Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

CONTENTS

★ **A Study of Coal Analyses from the Standpoint of the User.** 68
By Fred M. Reiter

★ **Seagram's Combination Boiler-Spray Drier Features Ease and Economy of Operation** 74
By Cyrus R. Buck and Nelson Roberts

What Will Future Steam Power Plants Cost? 78
By William C. Rowse

Overhead Wires and the Legal Limits of Liability 84
By Albert Woodruff Gray

Design Factors in the Modern Steam Generator 86
By F. M. Swengel

★ **It All Happened in Fifteen Seconds** 88
By D. D. Higgins

Power Engineers' Digest 115

Regular Departments

Notes on This Issue - 5 — Engineers' Preview - 7 — Helpful Bulletins - 49 New Equipment News - 56 — Catalog Library - 60 — Power Plant Construction News - 64 — Letters to the Editors - 67 — New Engineering Books - 120 — News from the Field - 130

* * *

The PRACTICAL ENGINEER and ELECTRICIAN

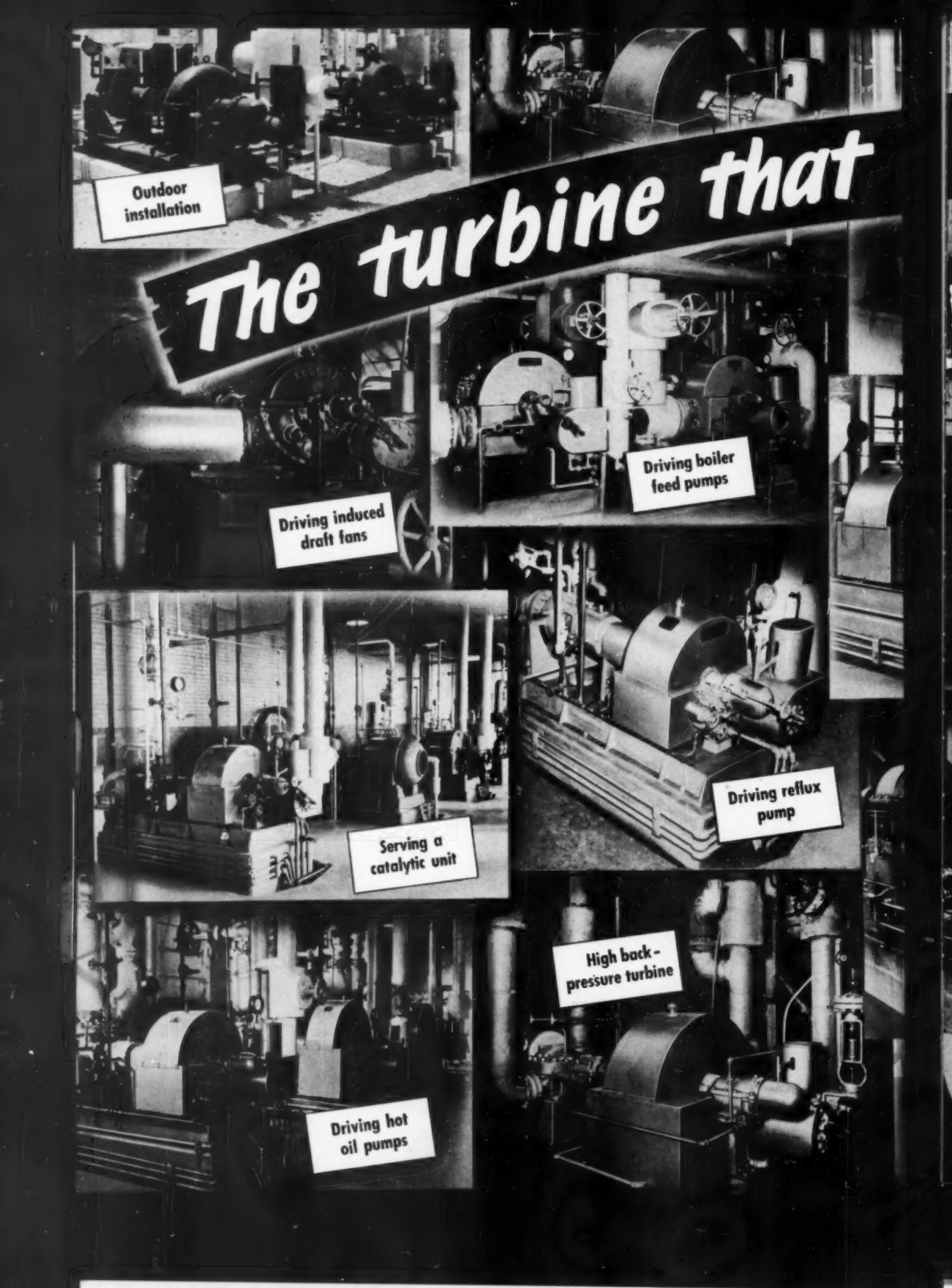
See Page 91 for Full Contents

Sawdust—How to Burn the Stuff . . . Take Your Steam Samples in Saturated, Not in Superheated, Steam . . . How to Insulate Large Vessels . . . Some Maintenance Jobs You Can Do with Cold Pressure Welding . . . Sulphur in Fuel Oils . . . Basic Power Plant Figuring . . . Automatic Control for Molding Machines . . . Beryllium Discontinued in Fluorescent Lamp Manufacture . . . Questions and Answers

Got Piles of Coal to Analyze?
See F. M. Reiter's Study, page 68

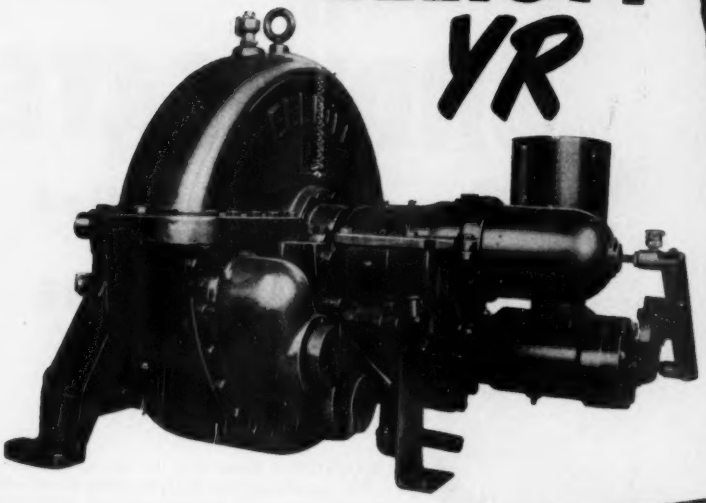
FEBRUARY
1951

TECHNICAL PUBLISHING COMPANY • CHICAGO, ILLINOIS


The turbine that
Outdoor installation
Driving induced draft fans
Driving boiler feed pumps
Driving reflux pump
Serving a catalytic unit
High back-pressure turbine
Driving hot oil pumps

everyone likes...

ELLIOTT YR



Driving induced draft fans

Paper machine drives

Driving process pumps

YOU SEE THEM EVERYWHERE—in power plants, industrial and process plants, throughout the oil industry, in fact in all industries that demand reliability in mechanical drive turbines. Working indoors or out, under all kinds of conditions, operating condensing or noncondensing; sometimes operating on gas instead of steam. Although a standardized line of turbines, their flexibility results in a tailor-made unit for any type of application . . . And best of all, with the built-in dependability that lightens the load of the men whose job is to keep things running right.

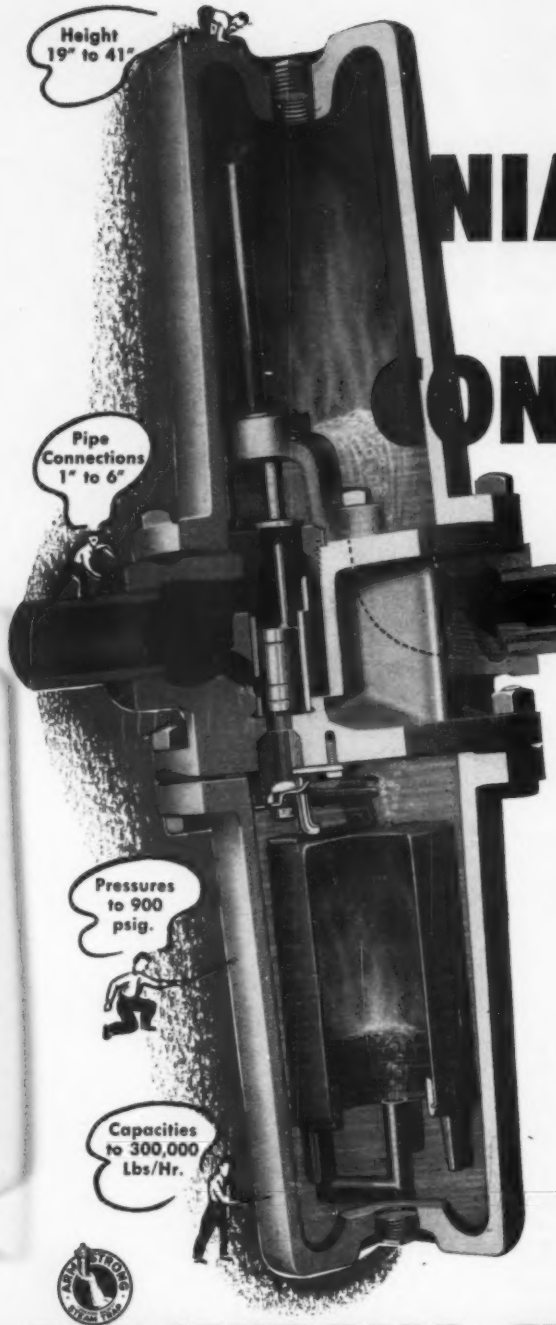
Everyone likes the Elliott YR. The reasons are factually set forth in Bulletin H-16. Write for it.

ELLIOTT COMPANY

Steam Turbine Dept. • • Jeannette, Pa.

Plants at: JEANNETTE, PA. • RIDGWAY, PA. • AMPERE, N. J. SPRINGFIELD, O. • NEWARK, N. J. • DISTRICT OFFICES IN PRINCIPAL CITIES

H-730



NIAGARAS of CONDENSATE

can be handled with ARMSTRONG *Compound* STEAM TRAPS

WHERE there is a lot of condensate to handle in a hurry, Armstrong Compound Steam Traps fill the bill to perfection. They will take sudden as well as normal loads in stride — give you dependable, automatic drainage of purifiers, separators, de-superheaters, flash tanks, headers, hot water heaters, continuous blowdown systems and process equipment.

In these traps a standard Armstrong inverted bucket trap mechanism actuates a piston-operated discharge valve with a much larger orifice than could possibly be considered in an ordinary trap. The result is a thoroughly dependable trap which is surprisingly small and compact in relation to its capacity. For full details call your Armstrong representative or write: ARMSTRONG MACHINE WORKS 810 Maple St., Three Rivers, Mich.

●*THE ARMSTRONG STEAM TRAP BOOK includes essential data on Compound Traps as well as traps for general service. You are welcome to a copy — no obligation. Write today.*

ARMSTRONG STEAM TRAPS

EDITORIAL STAFF

ANDREW W. KRAMER
Editor

CHESTER R. EARLE
Managing Editor

THOMAS E. HANSON
Associate Editor

EARL R. NOREN
Assistant Editor

RALPH E. TURNER
Consulting Editor

RICHARD H. MORRIS
Contributing Editor

MARIAN E. HENIKEN
Equipment Editor

JAMES E. WILCOX
Staff Artist

SOCIETY of BUSINESS MAGAZINE EDITORS

TECHNICAL PUBLISHING CO.
110 S. DEARBORN ST.
CHICAGO 3, ILLINOIS

KINGSLEY L. RICE, *President*
EDWIN C. PROUTY, *Exec. Vice Pres.*
WALTER PAINTER, *Vice President*
EDWIN C. PROUTY, JR., *Secretary*
ARTHUR L. RICE, JR., *Treasurer*
RALPH E. TURNER, *Editorial Advisor*
JOHN O. AARVOLD, *Prod. Manager*

RICHARD M. WARD
Vice President in Charge of Sales

DISTRICT MANAGERS

CHICAGO: Arthur L. Rice, Jr.
John R. Morrison
110 S. Dearborn St., Chicago 3, Ill.
Phone: DEarborn 2-5446

NEW YORK: George L. Wright, Jr.
Oscar Wilds
860 Graybar Bldg., New York 17, N. Y.
Phone: Murray Hill 5-3779

PHILADELPHIA: Oscar Wilds
1235 Jericho Road, Abington, Pa.
Phone: Ogontz 7261W

CLEVELAND: Richard M. Ward
2945 Fairmount Blvd.
Cleveland Heights, Ohio
Phone: Fairmount 1-0616

PACIFIC COAST: McDonald-Thompson
Roy M. McDonald, Mgr.
625 Market St.
San Francisco 5, Calif.
Phone: Yukon 6-0647

Edwin T. Thompson
3727 West Sixth Street
Los Angeles 5, Calif.

Harry Abney, Mgr.
Terminal Sales Bldg.
Seattle 1, Wash.
Phone: Main 3860

SOUTHWEST: McDonald-Thompson
Richard C. Wipperman
McDonald-Thompson
1118 Odeans Drive
Dallas 11, Texas
Phone: Winfield 4911

Subscription Information — Published Monthly. Prices: United States and Possessions one year $10.00, Canada one year $11.00. Other countries one year $12.00. Single copies $1.00. The Annual Index is furnished as a part of the December issue.

Contents of back issues of Power Plant Engineering and Power Generation and Power Engineering will be found in both the Industrial Arts Index and the Engineering Index on file in Public Libraries.

Copyright, 1951 by Technical Publishing Co.

CCA *Acceptance under Section 34.64 P. L. & R., authorized by United States Post Office.*

Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

Established 1896 as Practical Engineer. Title changed to POWER PLANT ENGINEERING in 1918, to POWER GENERATION in 1948; and to POWER ENGINEERING in May, 1950. Rights reserved to above titles.

February, 1951

VOLUME 55—NUMBER 2

Notes on This Issue

Coal Analysis

Do you know if you're getting what you pay for in the coal you burn under your boilers? Does it really conform to the specifications set forth in your contracts? How good are your laboratory reports—how good are your coal analyses? If you know the answers to all of these questions you probably need not read Fred Reiter's article on Coal Analyses in this issue, but if you don't you will find Mr. Reiter's discussion of great interest and value. Mr. Reiter is Materials Research Engineer for the Dayton Power & Light Co., and his description of the methods his company uses in the purchase and analysis of the hundreds of thousands of tons of coal they burn each year provides an engineering study of absorbing interest and unusual practical value. You may recall Mr. Reiter's article on the fungicidal treatment of manila rope in the October issue.

What Will Future Power Plants Cost?

With the way prices of everything are going, how can anybody know what a new plant or extension to a new plant might cost a year or two years from now? Is there any way of even making a reasonable guess in regard to future costs? Curiously enough, there is—a very simple method too, as you will discover if you read William Rowse's article in this issue. Mr. Rowse is a former engineer of steam design for the City of Los Angeles. Now, however, he is a consulting engineer, and in his continual struggle with estimates and costs, devised a method for estimating future plant costs. This method is based on widely published and easily available cost data on power plants built during different cost periods. In his article, Mr. Rowse puts dollar signs on the various factors involved and works out an actual example, estimating the cost of a plant proposed for completion by the end of 1952.

Bottled in Bond

Connoisseurs of good whisky know that the stuff that comes out of the Seagram Distillery is usually very palatable. Three years ago we described the Seagram plant in these pages. Now, Messrs. Buck and Nelson, who have operated this plant, tell how a combination boiler and spray drier has resulted in great economies, also, how easy it has been to operate. We think this account deserves a green label.

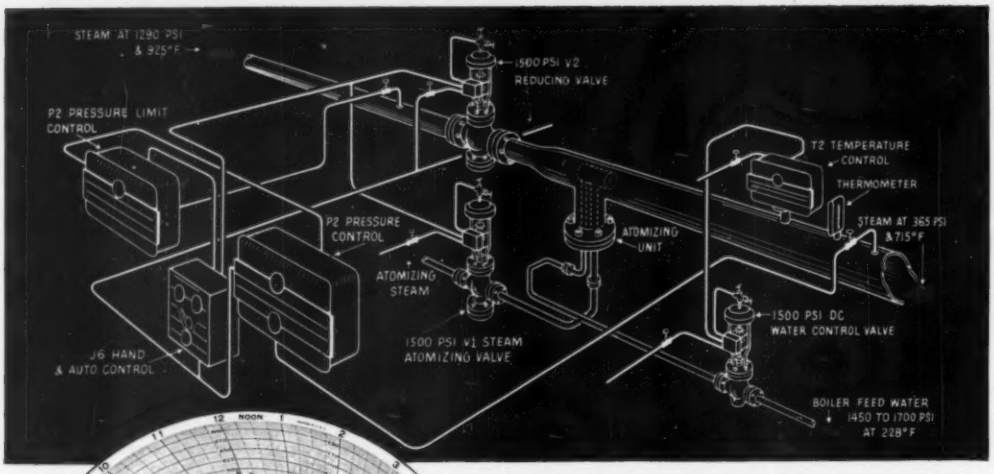
It All Happened in 15 Seconds

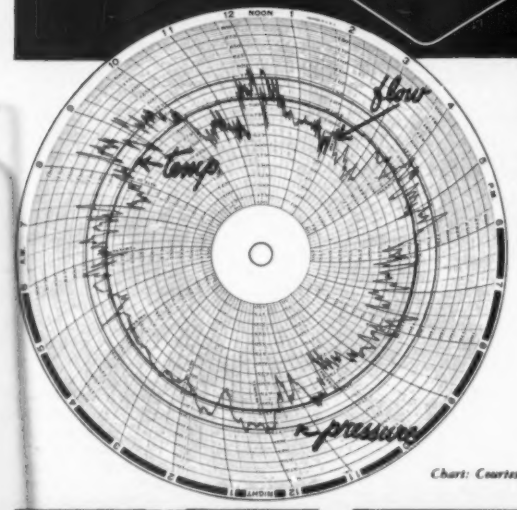
Offhand, it seems that only an exceptionally long-winded author would need three pages to describe an event that lasted only 15 seconds, yet Mr. Higgins who wrote the article under this title is anything but long-winded. Only an electrical man, dealing with the hundreds of thousands of kilowatts on a large utility system can appreciate how much can happen in 15 seconds when something goes wrong. Something did go wrong in this case — a dreamy operator, somehow or other, without thinking, weakened the field of a large generating unit connected to the Commonwealth Edison system serving Chicago. What happened after that was short but not sweet but, fortunately, the operator acted in time, and the day was saved. The automatic, recording instruments showed what happened but only Mr. Higgins' clear and masterful analysis was able to tell why it happened. Mr. Higgins is Superintendent of Generating Stations for the Commonwealth Edison Co.

Good News from Paul Schmidt

Readers of the Practical Engineer Section who have followed Paul Schmidt's excellent articles on the characteristics of fuel oil will be happy to learn, as we are, that he has made arrangements with the Industrial Press to have these articles published in book form in the very near future. We have had many requests for reprints of these articles.

Swartwout RDC* controls within ±1 psi and ±3°F even with widely fluctuating load swings


STEAM AT 1290 PSI & 925°F
1500 PSI V2 REDUCING VALVE
P2 PRESSURE LIMIT CONTROL
T2 TEMPERATURE CONTROL
THERMOMETER
P2 PRESSURE CONTROL
ATOMIZING UNIT
STEAM AT 365 PSI & 715°F
ATOMIZING STEAM
1500 PSI DC WATER CONTROL VALVE
J6 HAND & AUTO CONTROL
1500 PSI V1 STEAM ATOMIZING VALVE
BOILER FEED WATER 1450 TO 1700 PSI AT 228°F

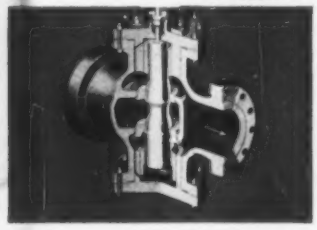


1 Chart shows how Swartwout RDC*—Reducing, Desuperheating and Control System—handles low-pressure turbine load of 65,000 to 165,000 lbs. steam per hour in Des Moines Power Station No. 2 of the Iowa Power and Light Company. It reduces from 1290 to 365 psi and desuperheats from 925° to 715°F. When main reducing valve closes, extremely light loads can be handled by pressure reducing valve supplying atomizing steam. Operation of the system is stable regardless of load change or time lag. Because of the exceptional control obtained by this large station, the Iowa Power and Light Company later purchased an additional small Swartwout RDC unit to supply steam to house turbines.

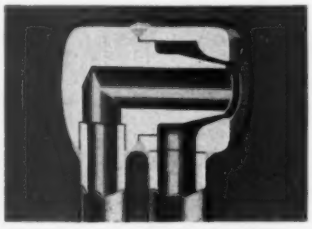
Swartwout

POWER PLANT EQUIPMENT

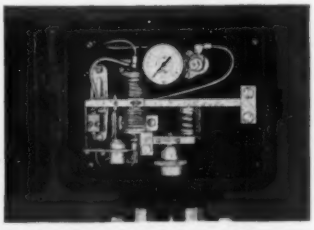
Chart: Courtesy Iowa Power and Light Company



2 Swartwout V-2 Regulating Valve has smooth, nozzle-shaped passages which guide expansion of high-pressure steam to reduced pressure zone without high-velocity impingement or other destructive forces common to conventional valves. Undue noise, turbulence and vibration are eliminated; longer valve life results.



3 Swartwout Steam Atomizing Desuperheater, constructed of stainless steel, has accurately machined passages that give narrow-angle dispersion of cooling water outside of steam atomizing head. There is no impingement of steam or water against walls of unit, no erosion of parts, no need for pipe liners.



4 Swartwout T-2 Control, with metallic temperature element in steam pipe, gives rapid and precise control regardless of magnitude of load or time lag. There are no flapper valves, relays or other delicate elements. Only two simple adjustments are involved; one for temperature, one for response. A-3092

SEND FOR BULLETINS S-21-E, S-22-C, S-198 • THE SWARTWOUT COMPANY, 18511 EUCLID AVENUE, CLEVELAND 12, OHIO

ENGINEERS' PREVIEW

A COWBOY'S DREAM CAR that works liks a horse has been developed for the famous King Ranch in Texas. Automotive engineers spent six months designing and custom building an all-purpose vehicle to meet the tough requirements of ranch boss Richard Kleberg. He wanted the car rugged enough to chase game and cattle across the rough country at 60 miles per hr, powerful enough to plow through sand dunes and luxurious enough to transport ranch visitors in high style.

The result is a dream luxury car with some of the characteristics and durability of a truck. It has a wrangler's seat with a safety belt on the right front fender for use at roundup time, triple gun holders built into the body, and a demountable stainless steel game holder. It has an oversized radiator, water storage tanks, and an extra-large fuel tank. A two-way radio telephone communicates with the ranch house, a power winch is installed and an altimeter, compass and tachometer are mounted on the dashboard. A hydraulic power mechanism assists steering through heavy sand. The car carries two spare wheels and a supply of tools in leather holders. Last, but not least in importance, a complete refreshment bar and ice box are concealed in the rear passenger space. The floor—you guessed it—is covered with calf hide.

★ ★ ★

KINGSBURY HALL, the new headquarters for the College of Technology at the University of New Hampshire, Durham, N. H., has been named in honor of Albert Kingsbury, best known as the inventor of the Kingsbury thrust bearing. The Hall was dedicated in October, 1950. Dr. Kingsbury was the first Professor of Mechanical Engineering at the University of New Hampshire and was an international authority on bearings and lubrication. He died in 1943.

★ ★ ★

IGNIPOTENCE is something that every power engineer possesses. It means very simply lordship over fire. The word Ignipotence was chosen by R. J. Sarjant as the title for the 1950 Melchett Lecture that he delivered at the opening meeting of the Institute of Fuel in October, 1950, in England. In his lecture, he discussed some very interesting aspects of combustion and heat transfer, heat transmission in tubes, heat transmission in furnace practice and various aspects of coke. The lecture is reprinted in full in the December 1950 issue of our English contemporary, ***The Engineering and Boiler House Review.*** The author says that, for the time being, Ignipotence is and probably for many years to come will remain at the source of mechanical and electrical power, and thus must be regarded as the basis of modern civilization. Without it our command of winter and our power to inhabit the open spaces of the world would disappear, civilization would decay and mankind might revert to barbarism.

★ ★ ★

GROUND HAS BEEN broken at East Chicago, Indiana, by Linde Air Products Co., subsidiary of Union Carbide & Carbon Corp., for an extension to the company's plant producing high purity oxygen. This, according to the Chicago *Sun-Times,* will make it the nation's largest single plant of this kind. Completion is scheduled for some time in 1952.

WHAT! You haven't heard about the latest development in the electrical field—the direct-current sychronous motor? What won't they think of next! Look at the bottom of column 1, page 73, November issue and also look at Fig. 2 on page 74, where you will see one of the air compressors driven by these motors.

All kidding aside, this is really a prime item for the red-face department. Of course, there is no such thing as a direct-*current* synchronous motor, as you knew all along. What Mr. McDermid wrote in his article was that some of the compressors were "driven by direct-*connected* synchronous motors."

★ ★ ★

NEW SYSTEM of "remote control" dictation has been developed by Thomas A. Edison, Inc. The TeleVoice System, as it is called, consists of from one to twenty modified telephones directly connected to a central recording instrument located near the secretary.

The recording instrument, called the TeleVoicewriter, records the dictation received on plastic discs. Transcription of the dictated matter is accomplished with the standard Edison Disc Secretarial Unit.

The TeleVoice Stations (phone extensions) can be located any distance from the TeleVoicewriter. Each station gives the dictator every one of the services he needs to dictate easily and accurately, including a means of listening back to what he has said and the facility for recording corrections.

The dictator has only those functions to perform which are a direct part of actual dictation. The secretary takes care of changing the discs and index slips. Since the work is delivered to her by direct wire, her flow of work is even and messenger services are minimized.

★ ★ ★

THE NEW "OIL MADE OF METAL" introduced ten months ago (See Engineer's Preview, April, 1950, issue) by the Lubricants Division of the Lockrey Co., has opened up so many new possibilities in machine design by providing safe lubrication at higher speeds, pressures and temperatures than ever before possible, that the company has been forced to develop several new forms of this molybdenum-base lubricant to meet especially severe conditions. Their Technical Bulletin No. 21-E just published describes four new types, Liqui-Moly NV Regular and Grease, Liqui-Moly NV Thread Compound and Moly-Wax Stix. Liqui-Moly is a specially-treated compound of the extremely "greasy" metal molybdenum, which has the peculiar property of attaching itself by molecular attraction to metal bearing-surfaces, forming a lubricating film that cannot be "squeezed out" by any amount of pressure, and which can withstand unbelievable extremes of temperature without affecting its lubricating qualities. The Lockrey Co. has perfected a method of incorporating this material in a volatile liquid having the appearance of oil but containing no oil, and this liquid serves to transport the metallic lubricant to the bearing-surfaces where the vehicle evaporates off and allows the molybdenum to "plate out" on the bearing-surfaces. The result is a perfectly dry but perfectly lubricated bearing, safe at extreme pressures, speeds and temperatures, and having many times the efficiency and life of conventional lubricants.

PREVENTING Fuel Explosions in Gas and Oil Fired Manual-Lighted Boiler Furnaces is the title of a new Loss Prevention Bulletin, No. 14.25, published by Factory Mutual. This publication discusses in detail the proper lighting-off and firing procedures recommended for such boiler furnaces. It then gives details of safety measures and equipment for gas fired manual-lighted boilers. It shows sugggested application of combustion safeguards of the flame-rod type to several well-known types of burners, explains in detail the FM cock and gas safety control system and its application and gives recommended procedures for gas firing. The bulletin then discusses the hazards of oil-fired manual-lighted boilers, gives data on how to minimize them, discusses the principal types of oil burners and the combustion safeguards used with them and gives recommendations for oil firing. It concludes with some data on soot blowing in oil-fired boilers. Bulletin No. 14.25 may be obtained from Factory Mutual Engineering Div., Associated Factory Mutual Fire Insurance Companies, 184 High Street, Boston 10, Mass.

★ ★ ★

TIME is not far off when such items as high-pressure compressor cylinders, supercharged Diesel engine crankshafts, pistons and other parts subject to severe mechanical service will be produced from the new nodular iron, according to T. E. Eagan, chief metallurgist of The Cooper-Bessemer Corp. Many highly stressed engine and compressor parts, which heretofore have been produced from more costly cast steels or steel forgings, can now be successfully made from nodular iron, explains Mr. Eagan. With the high tensile properties as well as the ductility being developed in nodular iron, it is apparent that this new material will in the near future gain widespread use, not only in the engine and compressor building industry, but on other types of petroleum processing equipment where high pressures are encountered. Nodular iron is now being produced possessing tensile strengths exceeding 90,000 psi. Ductility is averaging ten times that possible with cast iron. Fatigue tests conducted on high-pressure cylinders are demonstrating that nodular iron equals and in many cases exceeds the fatigue endurance that can normally be carried with mild cast steel.

★ ★ ★

ANAEROBIC PERMAFIL is a new material that remains liquid as long as a stream of air bubbles through it, but hardens in a few minutes when away from air. It has been developed in the chemistry divisions of the G-E Research Laboratory. Its properties are thus opposite to those of paint, which hardens when exposed to air.

According to Dr. C. G. Suits, G-E vice president and director of research, this new material is able to penetrate extremely small cracks before hardening. Thus, a possible application is a tight seal for stopping nearly invisible leaks, or a "pipe dope" for sealing threaded unions. Laboratory scientists responsible for the new development are Dr. Robert E. Burnett and Birger W. Nordlander.

Anaerobic permafil is the latest in a series of related compounds called "permafils," which the G-E chemists have developed, said Dr. Suits. Originally they were called "solventless varnishes." When two metal strips are coated lightly with anaerobic permafil and clamped together, the joint will support 10 lb after 10 min. After 20 hr, it will hold 100 lb. If still faster hardening is desired, the permafil may be heated, up to 212 F, and solidification takes place in a minute or less.

AT THE NEW electric weld pipe mill of U.S. Steel's National Tube Co. at McKeesport, Penna., water under pressures as high as 3,000 psi is used to expand the diameter of big pipes. This expansion process makes it possible to produce pipe to the exact outside diameters required by customers. It also adds strength to the steel.

The pipes are made from heavy plates 40½ feet in length, from ¼ to ½ inch in thickness and varying in width from 79½ to 110½ inches. Each plate weighs from 2 to 3 tons. Special presses round the plates into tubes. The seam is welded inside and out. The tubes are then inspected and pass to the expander.

This machine is equipped with a fixed plug on one end and a movable ram on the other. Both the ram and the plug are tapered and fitted to insure watertight connections when the pipe is in place. Pressure on the ram forces the tapered fittings into the tube, swelling the ends into a bell shape. Locked in place around the pipe is a die, machined to limit the stretch to the exact diameter specified by the customer.

Three pumps force water into the pipe from a 25,000-gal reservoir. The thickness of the steel in the pipe walls determines the pressure needed.

As the pipe enlarges in diameter, naturally it is reduced in length. The ram automatically advances to maintain a tight seal on the retreating ends of the pipe. When the tube is tight within the die, water pressure is lowered, the dies are opened and the pipe is tested and thoroughly inspected. The ends are then beveled

★ ★ ★

REGULAR readers of *Power Engineering* for as much as 10 years will remember the name of J. G. Mingle signed to many notable articles on combustion and, in particular, on chimney design and construction. He has also written the only textbook we know of dealing solely with chimneys.

Well, the last word we had from him was that he was being appointed Superintendent of the Air Pollution Bureau in Indianapolis. As might be expected from a good engineer, already he has most of the city singing his praises, especially the newspapers. Mr. Mingle, known to his friends and acquaintances throughout the country as "Si" had just about taken off his coat and hat preparatory to tackling the job of cleaning up the air over the Indiana Capital, when John Lewis decided to call a strike.

To a less resourceful man that might have been the signal to say "No need to start now until the fuel supply becomes normal again."

But not Si. He quietly called leading apartment house managers and owners together. Also the coal dealers, "Let's not postpone this air purification program just because we have a coal strike." Mingle said, "I think the three of us can lick the problem. If you boys will agree to co-operate, my department will make personal visits to all smoking plants. We won't 'crack down' on them but we will do everything in our power to teach the operating personnel how to avoid producing smoke and pollution."

This is the right approach to the air pollution problem with small installations. It is working for Mingle, say the citizens and newspapers of Indianapolis. It has worked in many other cities where it has been tried. It's engineering, not politics. True, the engineers sometimes run into individuals who are reluctant to cooperate. Then the whip may have to be cracked. But the real trouble in most cases is caused by physical factors of fuel, furnaces and boiler installations, and lack of proper knowledge on the part of their operators.

Edward INSTRUMENT Valves

For Orifice Meters, Regulators, Gage Lines, Instrument Panels, Christmas Trees, By-pass Lines, etc.

HERE'S A NEW DESIGN in instrument valves — forged steel for strength in high temperature or high pressure service; no bonnet joint, swing bolted gland for easy packing adjustment.

Compact enough to fit the limited spaces of panel boards, this new Edward instrument valve is especially designed for close regulation on meter and regulator lines, too.

Built in globe or angle design, screwed or socket welding ends, ¼ in., ⅜ in., and ½ in. sizes. Working pressure ratings 6000 lb WOG, 1500 lb at 850 F with carbon steel bodies, and 1500 lb at 1000 F with 13 per cent chromium EValloy stainless steel bodies. Write today for Bulletin 491.

ACTUAL VALVE SIZE ▶

NEW FIG. 952 SERIES

EDWARD VALVES, INC.
220 West 144th St., East Chicago, Ind.

Please send me Bulletin 491—on Fig. 952 Series

Name_____

Company_____

Street_____

City_____ Zone____ State_____

Another Product

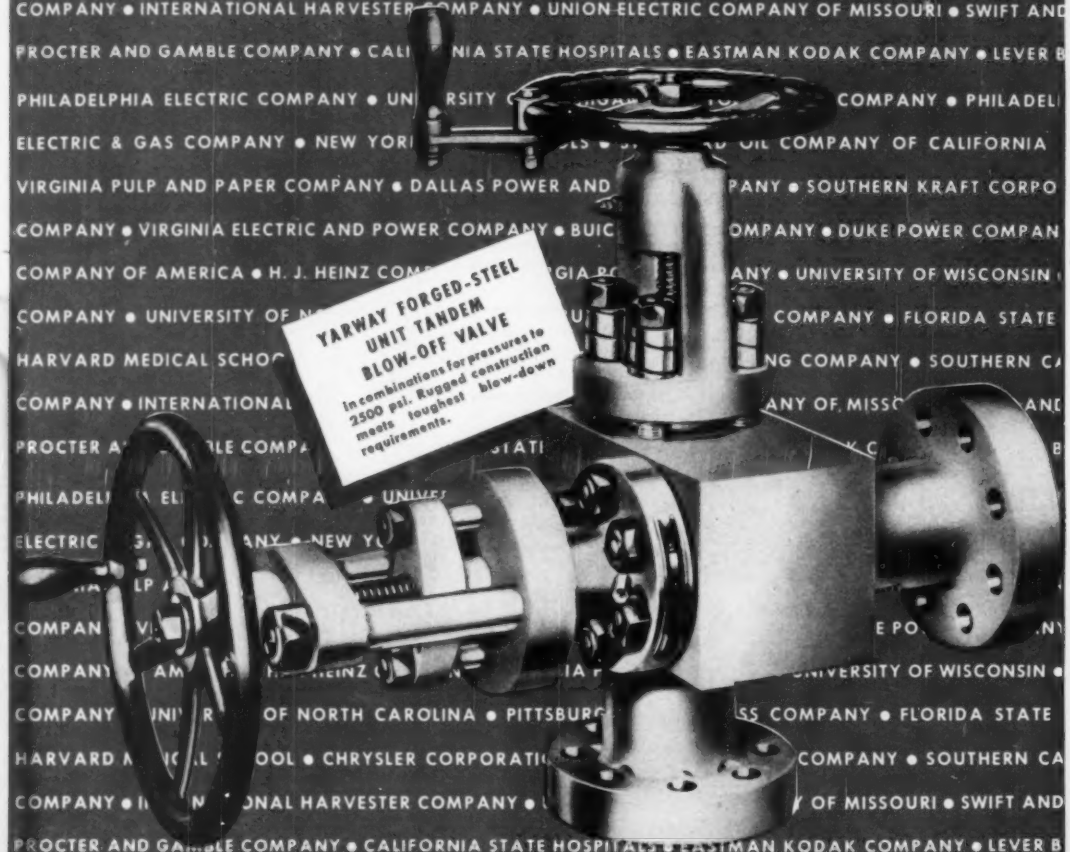
Edward Valves, Inc.

Subsidiary of ROCKWELL MANUFACTURING COMPANY

EAST CHICAGO, INDIANA

A BLOW-

IS KNOWN BY THE


YARWAY FORGED-STEEL
UNIT TANDEM
BLOW-OFF VALVE
In combinations for pressures to 2500 psi. Rugged construction meets toughest blow-down requirements.

YARWAY

OFF VALVE

BOILERS IT PROTECTS

HIA PUBLIC SCHOOLS • PACIFIC GAS & ELECTRIC COMPANY • IOWA STATE COLLEGE • PUBLIC SERVICE

BOSTO ... EST

ATIO ... TOR

E.I. ... UM

R. J. REYNOLDS TO... • CARNE... • HU... NING

HOSP... • ... • ... Y •

LIFO... • IO... ER ND... GHT

COMPANY • FLORIDA POWER COMPANY • ARMOUR AND COMPANY • UNIVERSITY OF PENNSYLVANIA •

When buying blow-off valves, weigh the significance of these two facts:

More than 15,000 boiler plants in the United States and other countries are equipped with Yarway Blow-Off Valves... Some of them for nearly 40 years. *Among high pressure plants, 4 out of every 5 in the United States are Yarway-equipped.*

Design, metallurgy, workmanship and service are the reasons. It was Yarway that brought out the famous Seatless Valve, teamed it with a stellited hard-seat valve in a common forged-steel body to make the popular Unit Tandem. Yarway has also made available metallurgical improvements to withstand the chemical reactions of acid wash as well as the mechanical wear of boiler blow-down.

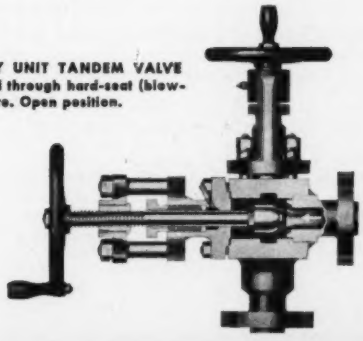
Yarway continues to pioneer and improve blow-off valves and blow-off valve service for both high and low pressure applications.

On new boilers, replacements or modernization, make sure you specify Yarway Blow-Off Valves. Any boiler manufacturer will supply them on your specification.

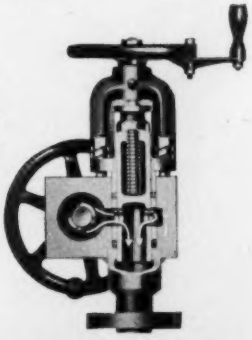
Bulletin B-424 gives you the full story on pressures to 400 psi. Bulletin B-433 for higher pressures. Both are free. Write...

YARNALL-WARING COMPANY, 114 Mermaid Ave., Philadelphia 18, Pa.

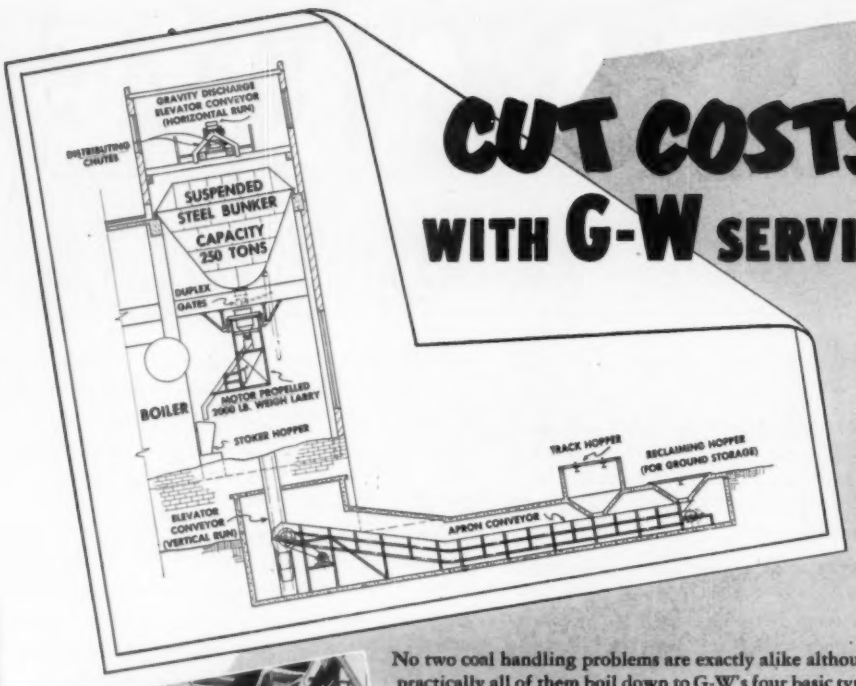
YARWAY UNIT TANDEM VALVE sectioned through hard-seat (blowing) valve. Open position.



YARWAY UNIT TANDEM VALVE sectioned through seatless (sealing) valve. Open position.



CUT COSTS WITH G-W SERVICE



G-W conveyor system with capacity of 60 tons per hour. System consists of a Rail and Truck Hopper, a 30-inch Apron Conveyor, Gravity Discharge Elevator, 250-ton Suspended Steel Bunker and a 2000-lb. Weigh Larry.

No two coal handling problems are exactly alike although practically all of them boil down to G-W's four basic types of storage and handling.

For example, at a large U.S. Government arsenal, G-W designed and installed the suspended steel bunker with a gravity discharge bucket elevator shown at left. Coal is carried on the upper run of the conveyor, permitting free access to machinery and maximum bunker capacity. A cab-type weigh larry with recording beam provides clean, economical operation.

4 BASIC WAYS TO CUT COAL HANDLING COSTS

No matter what your coal and ash handling problem is, from one of 4-basic types... Concrete Silos, Vitrified Tile Silos, Cylindrical Steel Tank, and Suspended Steel Bunker... G-W engineers can install the most efficient and economical storage and automatic handling system to fit your requirements of space, capacity and initial cost. Their recommendations to you, will be based on more than 140 years of design and engineering experience and on the performance records of hundreds of successful installations.

Fourteen interesting case histories, based on these 4 G-W basic designs, are described in Bulletin No. 300. Write for your copy, today.

GIFFORD-WOOD CO.

SINCE 1814

NEW YORK 17
420 LEXINGTON AVE.

Factory:
Hudson, N. Y.

CHICAGO 6
565 W. WASHINGTON ST.

G-W HANDLES IT... faster • easier • cheaper

6349

The ADVANTAGES of *Automatic Operation* are Now Available to Manually Operated DIAMOND G9B SOOT BLOWERS

Conversion is Easy in the Field

Before CONVERSION

MANUAL OPERATION

Operator opens valve in steam line . . . then pulls the chain that opens and closes the valve in head and simultaneously rotates the element. His time and attention are required throughout operation.

After CONVERSION

AUTOMATIC OPERATION

The operator simply opens a valve . . . the automatic air control then takes over and assures correct cleaning every time.

By means of a simple field change and the addition of power air, any manually operated Diamond Model G9B Soot Blower can be converted to automatic (air) operation. The sheave wheel, chain guide and chain of the manually operated blower are removed and replaced by the air control assembly and gear guard as shown at the right.

The converted G9B blower is set in operation simply by opening a valve at the blower; the unit then automatically goes through the preselected blowing cycle and stops. The valve is then closed manually. By addition of a control panel, full automatic SEQUENTIAL blowing is available.

The Diamond Model G9B is the most widely used of all soot blowers. This permanently installed (multi-nozzle element) steam blower of proven dependability has numerous outstanding features. Included are cam and trigger valve operation, flexible element connection and adjustable pressure control. To these can now be added the many advantages of automatic or automatic sequential operation at moderate cost. Conversion takes little time in the actual changeover, and the blowers are not removed from the boiler wall. Get in touch with the nearest Diamond office for further information or write directly to us at Lancaster, Ohio.

DIAMOND POWER SPECIALTY CORP.
Lancaster, Ohio
Diamond Specialty Limited • Windsor, Ontario

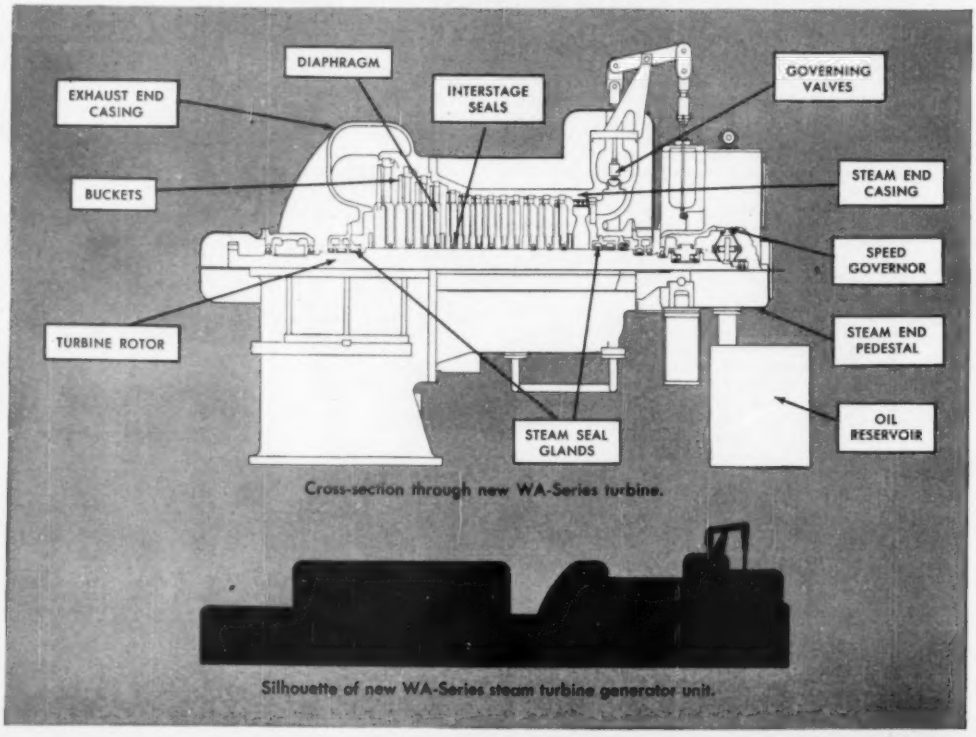
Diamond Short Retracting and Long Retracting Soot Blowers that are Manually Operated also can be Converted to Automatic Operation in the Field. • WRITE FOR INFORMATION.

4296

Allis-Chalmers

the WA

A Fully Modern Turbine Generator



Cross-section through new WA-Series turbine.

Silhouette of new WA-Series steam turbine generator unit.

Announces...

WA Series

Line of Steam Units; 500-7500 Kw

NOW IN PRODUCTION at Allis-Chalmers is the WA-Series of all-impulse steam turbine generators . . . embodying the most recent design developments! This series covers NEMA ratings in the range from 500 to 7500 kw inclusive. They are being built for both condensing and non-condensing service, with or without automatic extraction.

The WA-Series brings to the industrial and utility power plant the economies of repetitive manufacture as well as the design refinements proved in the larger units. The WA-Series incorporates flexibility of design to meet a wide variation of application requirements.

This modern design combines the very newest developments in impulse turbines and self ventilated generators. Allis-Chalmers—builder of steam prime movers for over 80 years and turbine builder for nearly half a century — has units of all types, and up to 150,000 kw in service.

The WA-Series units are functionally attractive and will be the central feature of any power plant. Turbine, generator and exciter are all especially engineered to operate together. The entire unit is designed, manufactured, assembled, and tested under one supervision at one plant.

For top performance in generation, with or without the economies of by-product steam, investigate the features of the new WA-Series. Be sure your next turbine generator has *all* the latest features!

Contact your nearest Allis-Chalmers office for full information on the advantages a WA-Series 500 to 7500 kw turbine generator will bring to *your* power plant. Main offices at Milwaukee 1, Wisconsin.

A-C

ALLIS-CHALMERS

TURBINES & GENERATORS • CONDENSERS & PUMPS • MOTORS & CONTROL
SWITCHGEAR & BREAKERS • TRANSFORMERS • WATER CONDITIONING

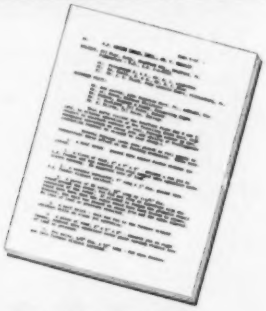
World's Widest Range of Power Plant Equipment

A-3233

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

A group examines some of the foreign material used in a punishing test of the feeding mechanism of a Centrafire with Traveling Grate. The original demonstration was conducted at the Westinghouse Plant at Trafford, Pennsylvania, on May 8 and 9, 1950. If you would like to see this test repeated, ask your nearby Westinghouse Steam Specialist for a showing.



YOURS FOR THE ASKING

Send for the complete report on the Centrafire with Traveling Grate test. Books are also available on either the Traveling Grate or Link-Grate Centrafire Stokers. Write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

COULD YOUR STOKER PASS THIS TEST?

The ability of the Centrafire with Traveling Grate to "take it" and continue to operate without loss of load under extreme conditions has been repeatedly demonstrated in tests like this one. Wet fuel and extraneous matter were handled without interfering with operation. Tests such as this prove that Centrafire feeders are virtually non-stallable. The unusual or large obstruction that causes difficulty is quickly and easily removed. Read these excerpts from the actual test report:

- **A half brick**—passed through center feeder without incident on both rotor and steam-jet operation.
- **Blocks of wood**—of two sizes, both sheared pins in feeder, but were removed without loss of load or pressure.
- **Ceramic insulator**—passed through feeder without incident.
- **A piece of BX cable**—3½ feet long—wound around rotor, but did not stop or interfere with operation of the rotor.
- **Two bolts**—⅜" x 5½"—fed through feeders and into furnace without incident.
- **Steel cable**—forty-six inches of ½", fed through feeder endwise, worked through and into furnace without incident.
- **Market coal**—½" x 0", bone dry, was wet down at the coal conveyor and successfully fed into furnace without incident.
- **Extremely wet coal**—with continuous stream of water running out of all feeders—was fed with no adverse effect. Some wet coal accumulated on the feeder sills in the furnace but was easily removed with poker.

The outstanding performance of the Centrafire with Traveling Grate stems from features that are built in—not added as accessories. All moving elements are hydraulically operated by one turbine- or motor-driven oil pump. This assures infinite flexibility through the complete range of operation—synchronizes coal feed and grate speed. The Centrafire's range extends upwards of 300,000 lbs. of steam per hour. It will pay you well to get the full Centrafire Story.

J-50513

Westinghouse
STOKERS

You Save on 4 Counts with ENCO STREAMLINED BAFFLES

1 Better heat transfer

Enco's improved baffle design insures a uniform, high velocity gas flow over every square foot of heating surface.

2 Low draft loss

Smoothly curved baffles maintain a cross-flow of gases across the tube banks. Dead gas areas, bottlenecks and eddy currents are eliminated.

3 Less steam, less time for cleaning

Soot doesn't get a chance to accumulate in pockets. Soot blowers are used less often. Streamlined baffles lower maintenance costs.

4 Custom installation

Experienced Enco crews take charge of the installation, repairs and replacements of your individually designed streamlined baffles—do the job thoroughly and quickly with minimum downtime.

BULLETIN BW44 tells the full story, contains complete engineering data, explains how Enco Baffles provide maximum steam output with minimum fuel consumption. WRITE FOR YOUR FREE COPY TODAY!

THE ENGINEER COMPANY

75 WEST STREET, NEW YORK 6, NEW YORK

IN CANADA: R. A. BASKIN, LTD., 4230 FERRYDALE ST., MONTREAL 34 P.Q.

in flow metering

for EXTRA performance

in combustion control

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

combustion control systems . . . ring balance flow and pressure instruments

HAGAN RING BALANCE FLOW METERS

• sensitive • accurate • versatile

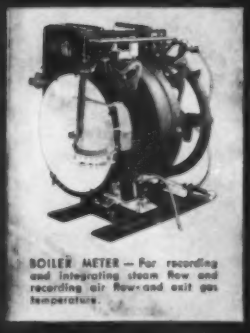
The extra performance of Hagan Ring Balance Meters is reflected in the characteristics of high sensitivity at low flows, accuracy in recording and integrating over the entire range, and *flexibility* that makes this the most versatile meter available today.

Measurements may be compensated for temperature or pressure, or both; compensated and uncompensated records may be obtained; and either may be totalized automatically.

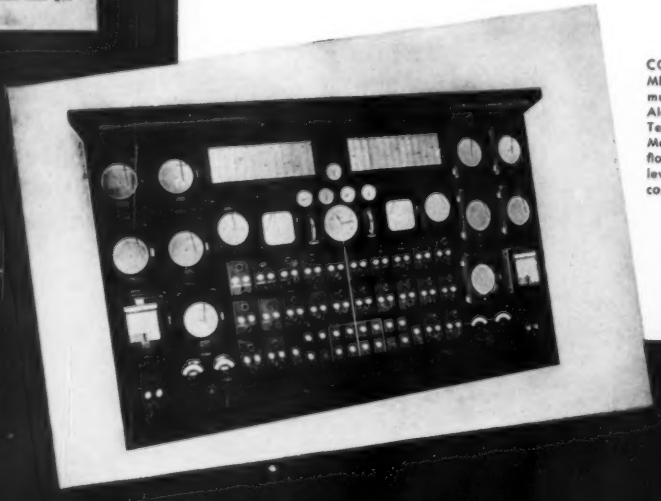
Measuring units for two flows may be housed in a single case. These flows may be recorded individually, and a record of their sum or difference obtained. Either or both flows may be totalized automatically.

Measurements of fluid flow, liquid level, specific gravity of liquids or density of gases are a few of the possibilities, for there is a Hagan Ring Balance Meter to meet virtually every metering requirement.

RECORDING AND INTEGRATING METER FOR SINGLE FLOW —(Case removed) For differential pressure from 0.5" to 420" water column. Static pressures up to 3000 psig.



BOILER METER — For recording and integrating steam flow and recording air flow and exit gas temperature.



CONTROL AND INSTRUMENT PANEL — Serving two multiple-fuel fired boilers at Alan Wood Steel Company. Ten Hagan Ring Balance Meters record gas flow, steam flow and boiler drum water level. Automatic combustion control is by Hagan.

HAGAN COMBUSTION CONTROLS

for every type of application

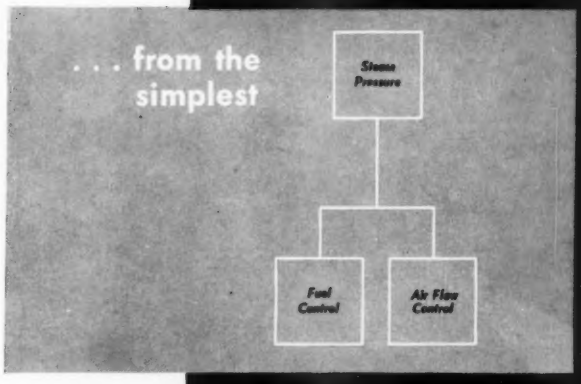
Hagan Control Systems have been supplied for boiler units ranging from 3,000 pounds per hour at 1.5 psi to 1,350,000 pounds per hour at 1800 psi.

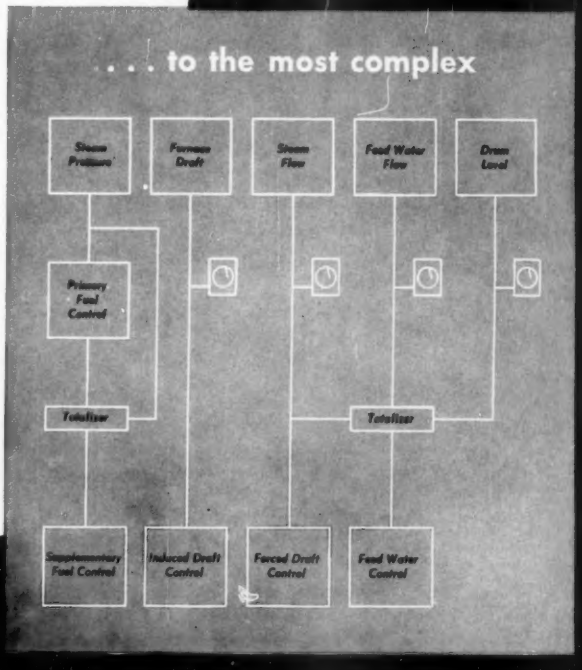
They are used on stoker fired boilers and on boilers fired with pulverized coal, natural gas, oil, waste refinery gases, blast furnace gas, coke oven gas—even sawdust.

They are used with single fuel firing, or with varying combinations of multiple fuel firing.

Hagan Controls provide *precise* control of the exact fuel-air ratio required for most efficient combustion. The same exacting requirements are fulfilled in applications on industrial and metallurgical furnaces.

Whatever your combustion control problem may be, Hagan engineers will be glad to discuss it with you.





METER ASSEMBLY for static pressures between 3000 and 15000 psig and pressure differentials between 20" and 140" water column.

PRESSURE COMPENSATED METER ASSEMBLY—Standard models may include automatic correction for variations in temperature and pressure.

DUAL METER for recording and integrating gas flow and recording air flow.

few meters have

ANY of these features

only HAGAN

RING BALANCE

has ALL

Hagan Ring Balance Meters have these inherent advantages:

1 ***They do not employ stuffing boxes,*** hence there is no danger of leakage; sensitivity is greater; adjustment is less delicate; less maintenance is required.

2 ***Mercury level is not critical,*** hence the meter is easier to calibrate, and is not thrown out of calibration by loss of mercury as long as enough remains to serve as a seal.

3 ***Dead weight calibration can be used***—a quick, easy and accurate method employing weights supplied with the meter. Meter need not be disconnected.

4 ***They are adjustable over a wide range of differentials*** —as much as 7 to 1 in some models—by a simple range screw.

For more information on these and other features of Hagan Ring Balance Meters, send for Bulletin 2M51, or write us concerning any particular application in which you are interested.

HAGAN

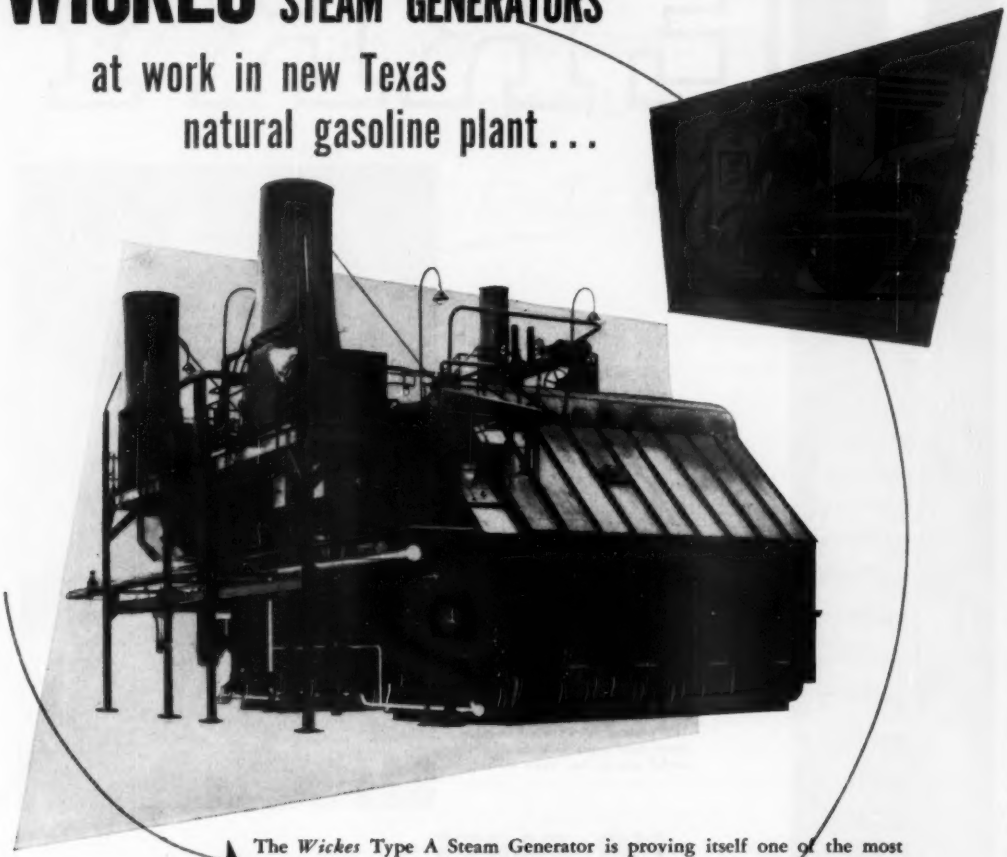
HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

ring balance flow and pressure instruments . . . combustion control systems

WICKES STEAM GENERATORS

at work in new Texas natural gasoline plant . . .



The *Wickes* Type A Steam Generator is proving itself one of the most serviceable boiler units employed by the oil and gas industry. These units, recently installed at a new Texas plant, each generate 80,000 pounds of steam per hour. The efficiency and ease of installation make the Type A boiler especially suited to the industry. *Wickes* can fill your exact requirements for boilers of any type up to 250,000 lbs. steam per hour and 850 p.s.i.

Wickes service facilities are world-wide and our knowledge of steam generation is available to you without obligation. Write for descriptive literature on the famous *Wickes* line of steam generators.

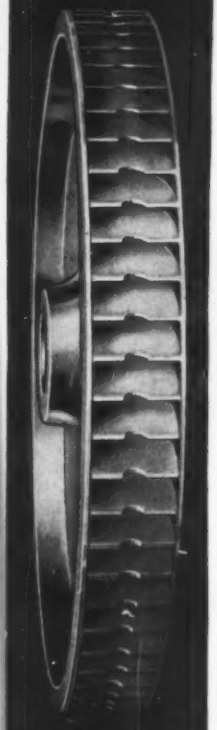
WICKES

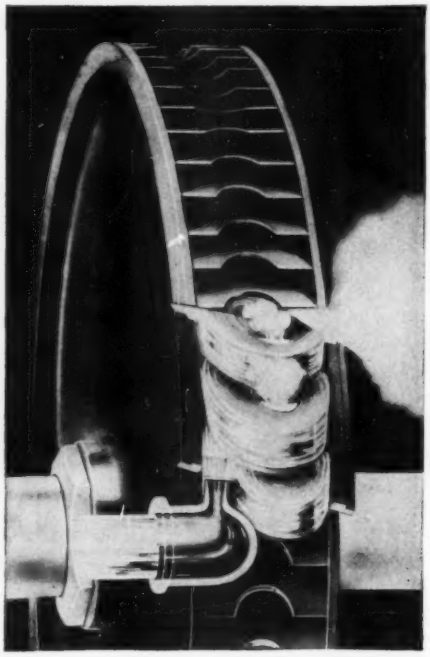
THE WICKES BOILER CO. • SAGINAW, MICHIGAN

Division of The Wickes Corporation • Recognized Quality Since 1854

SALES OFFICES: Atlanta • Boston • Chicago • Cincinnati • Denver • Detroit • Houston Indianapolis • Los Angeles • Milwaukee • New York City • Pittsburgh • Saginaw San Francisco • San Jose • Springfield • Seattle • St. Louis • Tulsa • Mexico City Buenos Aires • Manila • Havana • Montevideo • San Juan, P. R. • Victoria, B. C.

TERRY





Action of steam in Terry wheel turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket in which its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.

NO PARTS TO LOOSEN OR WORK OUT

The rotor of the Terry Wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the solid curved backs of these buckets or pockets. Therefore close clearance is unnecessary and wear on the blades forming the pockets is of little consequence, as it does not materially affect horsepower or efficiency.

For detailed information about this effective construction and its advantages, write us on your business letterhead for a copy of Terry Turbine Bulletin S-116.

T-1172

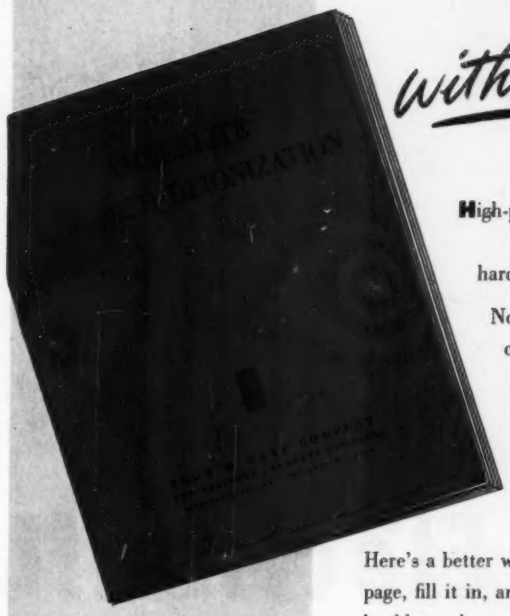
THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

Now— by AMBERLITE MONOBED DEIONIZATION

ZERO SILICA • ZERO HARDNESS • ZERO CARBON DIOXIDE

ZERO TOTAL IONIZED SOLIDS

without Evaporation!



High-pressure-boiler feedwater—passed *once* through a *single* bed of AMBERLITE ion exchange resins—is free of silica, hardness, carbon dioxide . . . of essentially all ionized solids.

No fuel is consumed, no heat is lost, no shutdowns for cleaning are needed. The cost of equipment—and of its operation—is low. The treated water contains less than one-tenth of one part of ionized solids per million parts of water—no matter how poor the quality of your raw water supply. And alkalinity is . . .

But we're getting ahead of our story.

Here's a better way to tell it. First, clip the coupon at the bottom of this page, fill it in, and mail it to us. When you've had a chance to read the booklet, ask your consulting engineer or manufacturer of water conditioning equipment how AMBERLITE Monobed deionization can insure the life and efficiency of your high-pressure boilers. Or, if deionization in *one* ion exchange unit doesn't quite suit your special needs, ask him how high quality water can be produced by various combinations of AMBERLITE cation and anion exchange resins, operating in *separate* units.

CHEMICALS FOR IND

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

The Resinous Products Division was formerly The Resinous Products & Chemical Company

AMBERLITE is a trade-mark, Reg. U. S. Pat. Off. and in principal foreign countries.

ROHM & HAAS COMPANY

Washington Square, Philadelphia 5, Penna.

Please send me your new 16-page booklet, "AMBERLITE Monobed Deionization".

Name_____

Title_____

Company_____

Address_____

City_____ State_____

PEI-11

Presenting the new

REPUBLIC Electronic

FEATURES

NO DEAD SPOTS OR LAGS

The TELEMASTER operates on a null-balance principle with a constant check-back between the initial input and final output, with no intervening mechanisms to cause dead spots or lags. This balance type detection of any deviation in the desired operating conditions, produces a highly responsive and fast acting control system.

ELIMINATES PANEL PIPING

No control panel piping is necessary with the REPUBLIC TELEMASTER. Easily installed, multi-wire cables are the only connection between the TELEMASTER benchboard and the plant measuring and control elements. Results? Easier, faster and better appearing installation, increased flexibility, economy, and reduced maintenance.

GREATER APPLICATION FLEXIBILITY

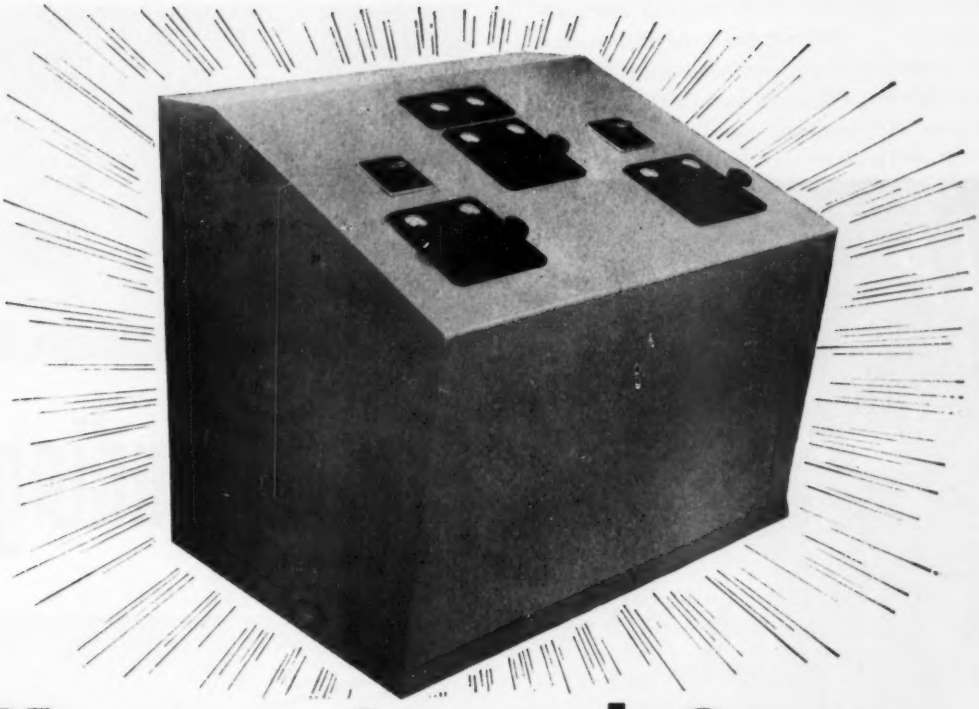
Flexibility required for complete centralization of controls at a central focal point is a distinct feature of the TELEMASTER. The system may be operated under completely automatic, semi-automatic, or manual control from a central supervisory station.

PLUG-IN INTERCHANGEABLE PARTS

Due to simplicity, compactness and interchangeable component parts the TELEMASTER provides a more flexible control system and a more condensed panel area than previously possible. All parts subject to replacement are mounted on compact plug-in units that are easily interchanged and replaced with spare parts.

REDUCED MAINTENANCE

Control room maintenance is sharply reduced. No moving parts or mechanisms are mounted on the control panels. Panel equipment is smaller and less cumbersome, no panel piping is used. Plug-in replacement parts may be installed in a matter of seconds. All components of the TELEMASTER are fully tested and proven for prolonged trouble free service.



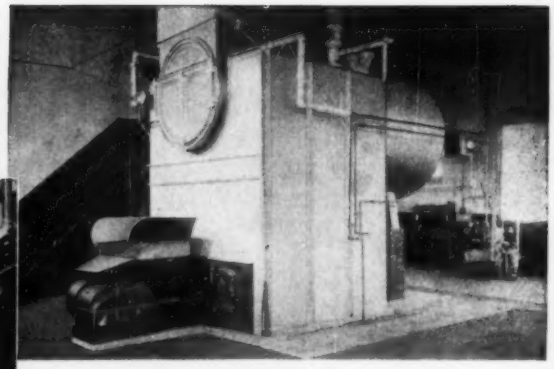
Master Control System

"TELEMASTER"

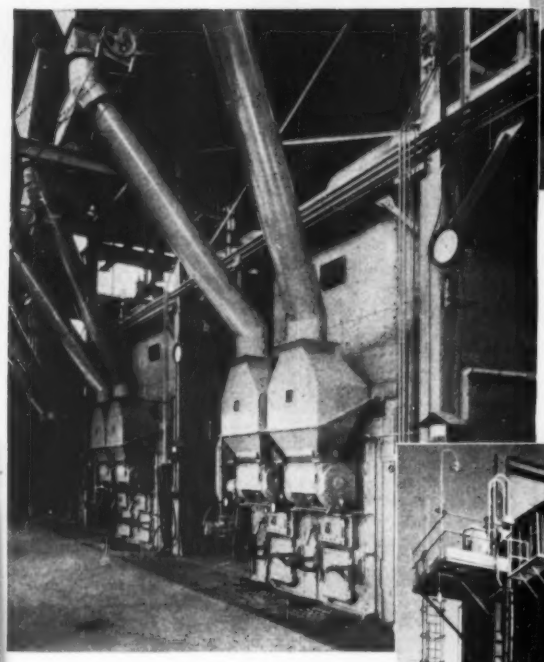
The new Republic Electronic TELEMASTER Control represents a major advance in the field of automatic control. The TELEMASTER will remotely reproduce, instantly and accurately, a position or a force — perform arithmetical and algebraic calculations—and can be used for multiple operations. Essentially it performs the function of a mechanical link through electrical and electronic means. It is applicable to all types of combustion and process control.

In plants where distances between operating units are great, the lags inherent in the compression effect of a pneumatic master system are appreciable. This effect is frequently sufficient to prevent realization of the full benefits of automatic control. The Republic Electronic TELEMASTER Control has no inherent lag, regardless of distance. This means that centralization of operations can be achieved without any sacrifice of control performance. *Full details sent upon request.*

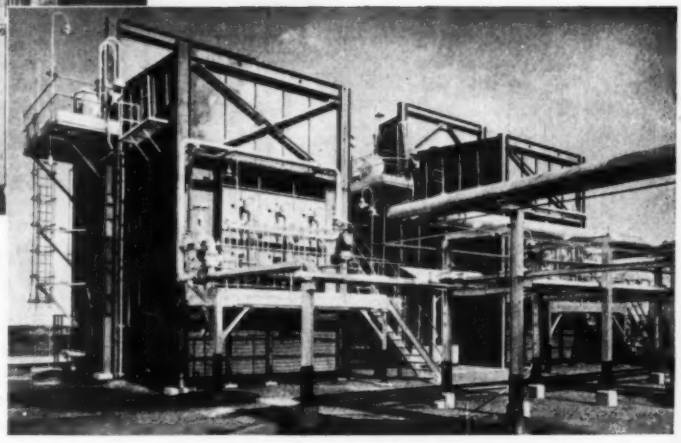
REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS



Planning



Installation for medium and smaller plants . . . pressure to 475 psi . . . capacity to 60,000 lbs. of steam per hr . . . suitable for any type of fuel.



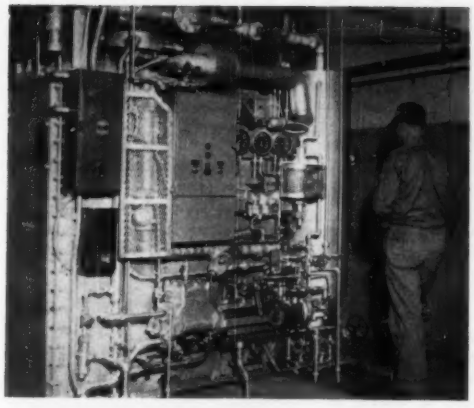
Installation for larger plants . . . pressure to 1000 psi . . . temperature to 900 F . . . capacity to 350,000 lbs. per hr . . . any fuel or type of firing . . . indoor or outdoor type construction.

COMBUSTION ENGINEERING

A MERGER OF COMBUSTION ENGINEERING COMPANY, INC. AND THE SUPERHEATER COMPANY

Installation for small plants . . . pressure up to 150 psi . . . capacity to 12,000 lbs. of steam per hr . . . adaptable to any fuel.

to buy BOILERS ... this year?



Installation for special conditions including very limited space . . . quick steaming (full capacity in 3 min.) . . . fully automatic operation . . . capacity to 6000 lbs. of steam per hr . . . pressure to 300 psi. Ideal for intermittent load.

Sometime this year, or perhaps next, your company may decide to buy new boilers . . . to replace obsolete units . . . to meet increasing steam demands . . . or for a new plant. Whatever the time or circumstances, here's something it will pay you to remember. With fuel and operating costs firmly established at new high levels, today more than ever before, the first cost of a new boiler is decidedly secondary to the annual operating cost. In fact, the annual cost of fuel alone for the average boiler installation nowadays usually equals or exceeds the purchase price. And the normal life of a boiler should be 20 to 30 years, or longer.

Obviously, then, the operating economies accruing from better design, construction or application, will quickly offset the difference between the cheapest boiler you can buy and the best the market affords. Here is one case where the old adage "the best is the cheapest" really applies.

In addition to having installed thousands of industrial boilers . . . in every size category from less than 100 horsepower up . . . Combustion has designed and built many of the country's largest utility power station boilers. And it is in this field – the manufacturing of power on a large scale – that boiler design and construction are evaluated most critically and exhaustively.

The fact that C-E Boilers have been selected to meet the exacting performance standards of so many of the nation's largest utility power stations is evidence of the quality of design and construction you can expect to find in any boiler, large or small, that bears the Combustion nameplate.

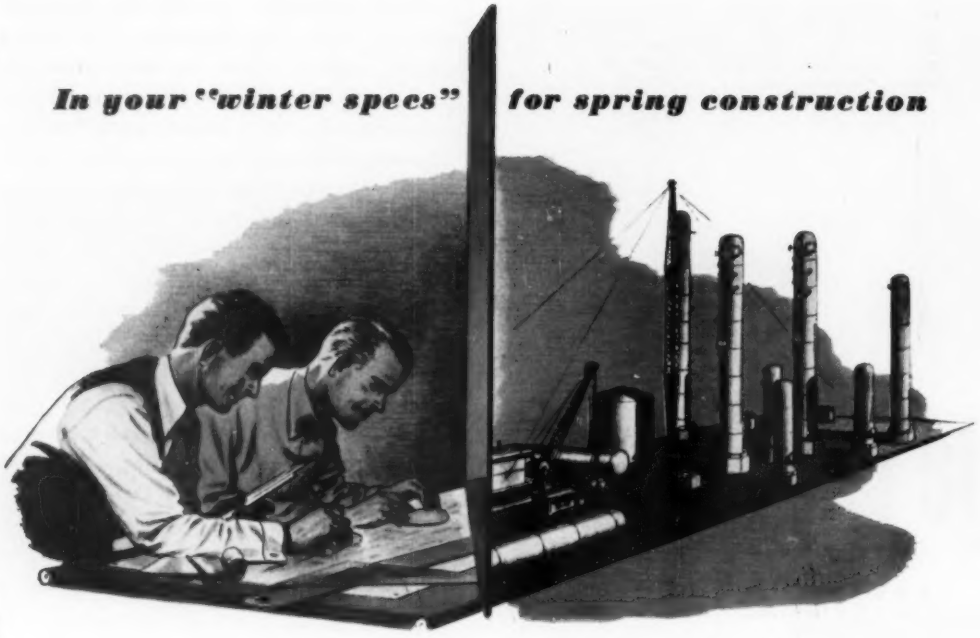
Our recommendations as to the most suitable type of boiler and firing equipment for the *specific requirements* of your next installation are available to you and your consultants without obligation.

B-383A

—SUPERHEATER, INC.

200 MADISON AVENUE, NEW YORK 16, N. Y.

In your "winter specs" for spring construction



It will pay you to consider these four advantages of a Fluor Pulsation Dampening Piping System . . .

1 **Pressure drop calculation based on smoother flow**

2 **Improved gas metering accuracy**

3 **Virtual elimination of piping maintenance**

4 **Consideration of safety records**

The Fluor Pulsation Dampening Piping System is the newest and most practical approach to "pulse-free" piping yet developed. Designed primarily for installation in new construction utilizing piping to handle air, steam, or hydrocarbons at operating pressures ranging from a vacuum to 5,000 psi at any temperature, this Fluor-designed piping system removes objectionable pulse peak pressures caused by the reciprocating action of compressors.

Fluor Pulsation Dampening Piping Systems are *guaranteed* to provide a virtually smooth gas flow with minimum pressure drop. Safety is increased by eliminating vibrational stress on piping, heat exchangers and vessels. Compressor operating efficiency is increased, metering inaccuracies caused by pulsative flow are reduced, and maintenance problems common to conventional piping systems are cut to a minimum.

If you are in the process of drawing up specifications for current or contemplated construction involving compressor piping, it will pay you to write for Fluor Bulletin No. PDS-8501. Or, contact your nearest Fluor Representative for attention to your particular problem.

FLUOR "PACKAGE-TYPE" PULSATION DAMPENERS

Fluor offers two "Package-Type" Pulsation Dampeners for installation in already existing piping systems. The first, a Fundamental Pulsation Dampener alleviates objectionable pulse frequencies contributing to vibration and pulsation of compressor piping. The second, a Higher Frequency Pulsation Dampener, removes the offending pulse frequencies in the higher range and is competitive in cost with muffler or snubber-type devices.

FLUOR

Fluor Pulsation Dampeners and Pulsation Dampening Piping Systems are protected by U. S. and foreign patents issued and pending.

BE SURE WITH FLUOR

DESIGNERS AND CONSTRUCTORS of Refining, Natural Gas and Chemical Processing Plants.
MANUFACTURERS of Pulsation Dampeners, Mufflers, Gas Cleaners, Cooling Towers and Fin-Fan Units.

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., Los Angeles 22, Calif. Offices in principal cities in the U.S.A.
REPRESENTED IN THE STERLING AREAS BY: Head Wrightson Processes Ltd., Teesdale House, Baltic St., London, E.C.I., England

IT ALWAYS PAYS TO SPECIFY

LADISH

Controlled Quality

PIPE FITTINGS

TO MARK PROGRESS

...you know they are in to stay

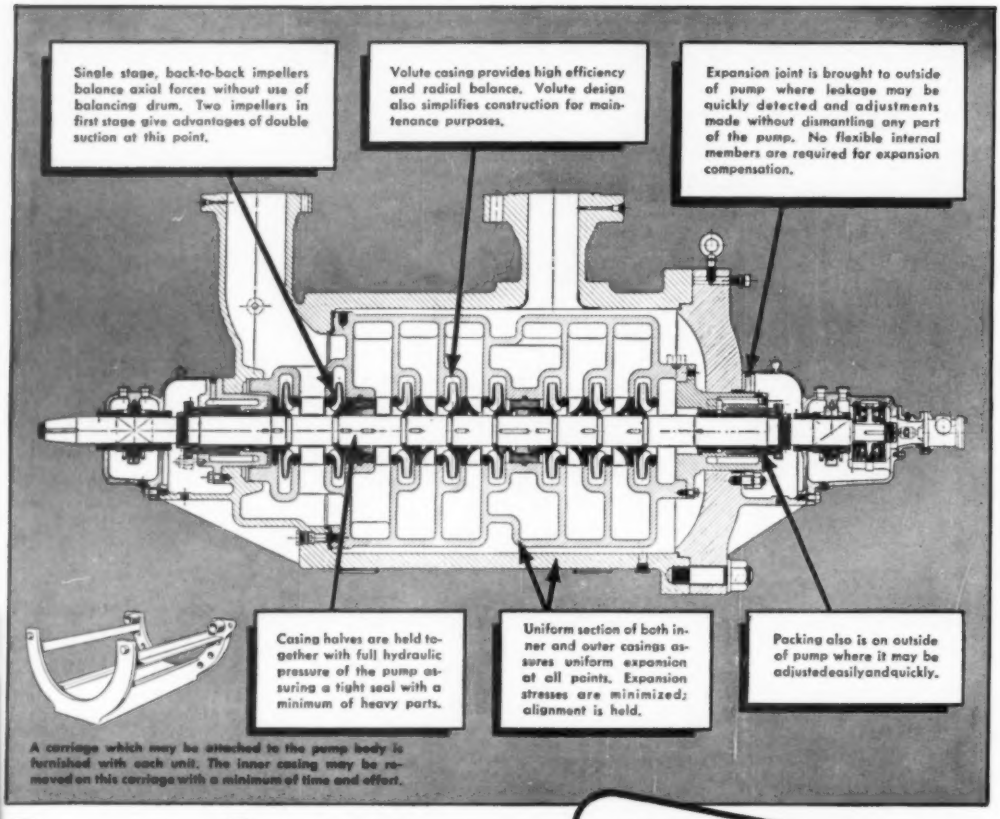
Long, trouble-free piping service results from extra safeguards in the manufacture of Ladish fittings. Rigid laboratory controls over chemical composition and physical properties of steel provide an assurance of maximum strength and resistance to erosion or corrosion. These are some of the extra safeguards for dependable operation which you always get in greatest measure in Ladish Controlled Quality Fittings.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

LADISH CO.

CUDAHY, WISCONSIN
MILWAUKEE SUBURB

District Offices: New York • Buffalo • Pittsburgh • Philadelphia • Cleveland • Chicago • St. Paul
St. Louis • Atlanta • Houston • Tulsa • Los Angeles • Havana • Toronto • Mexico City


Single stage, back-to-back impellers balance axial forces without use of balancing drum. Two impellers in first stage give advantages of double suction at this point.
Volute casing provides high efficiency and radial balance. Volute design also simplifies construction for maintenance purposes.
Expansion joint is brought to outside of pump where leakage may be quickly detected and adjustments made without dismantling any part of the pump. No flexible internal members are required for expansion compensation.
Casing halves are held together with full hydraulic pressure of the pump assuring a tight seal with a minimum of heavy parts.
Uniform section of both inner and outer casings assures uniform expansion at all points. Expansion stresses are minimized; alignment is held.
Packing also is on outside of pump where it may be adjusted easily and quickly.
A carriage which may be attached to the pump body is furnished with each unit. The inner casing may be removed on this carriage with a minimum of time and effort.

Cost Cutting Features

ALLIS-CHALMERS

NEW BOILER FEED PUMP

HERE IS A PUMP designed to meet the needs of the newer high pressure boiler plants. Efficiency is high, maintenance is low and every design feature has a long record of successful application to boiler feed service.

Sizes range from 1200 to 2500 psig and from 300 to 2000 gpm. Allis-Chalmers can supply the complete boiler feed pump installation including pump, motor and control, of coordinated design and manufacture.

Get the details on this new boiler feed pump from your Allis-Chalmers Sales Office or write Allis-Chalmers, Milwaukee 1, Wisconsin

A-3250

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

What NEW STANOIL'S *longer life means to you.....*

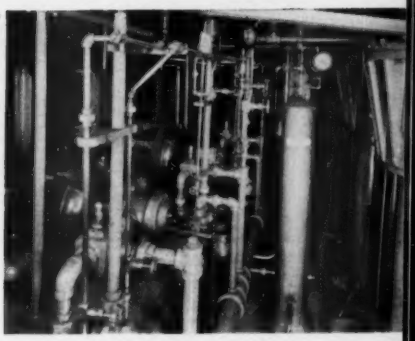
● For fourteen years STANOIL Industrial Oils have proved their ability to handle a wide variety of jobs in midwest plants. Now, these established products have been made better than ever! They offer new and important savings in an even wider variety of equipment because:

1. **Greater oxidation stability** in the New STANOILS enables them to stand up under high temperatures of operation, maintain low acidity for long periods of time, and reduce to the minimum deposits caused by oil oxidation.

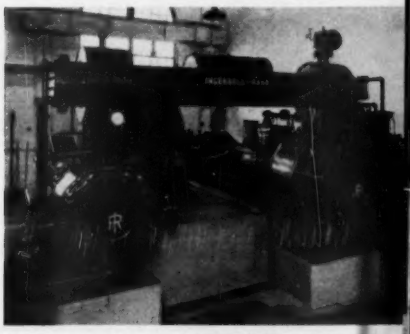
2. **High Viscosity Index and Low Pour Point** enable STANOILS to perform satisfactorily through a wide range of temperatures. They flow readily at low temperatures and do not thin out excessively at high temperatures.

3. **Greater protection against rust** has been provided by the addition of a corrosion inhibitor of an advanced type to all grades of New STANOIL. This inhibitor prevents corrosion trouble by "plating out" on surfaces that tend to rust. New STANOILS have practically put an end to rust and corrosion troubles.

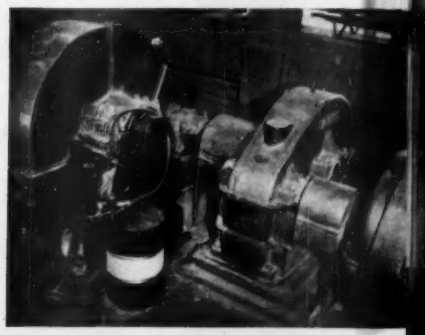
At the right are shown several types of equipment in which the New STANOILS can save you money and maintenance time. A Standard Oil Lubrication specialist will help you find still other applications where versatile STANOILS can replace many special-purpose oils. You can reach this man quickly and easily through your local Standard Oil Company (Indiana) office. Contact him today. Or, if you wish, write Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.



In Hydraulic Systems. Because of the high viscosity index and low pour point of the New STANOILS, they provide smooth operation in hydraulic systems regardless of widely varying temperatures. They also eliminate foaming, which is frequently troublesome in hydraulic operation. Their high oxidation stability eliminates deposits that could cause valve sticking and wear.



In Compressors. Because of the oxidation stability and low carbon-forming characteristics of STANOILS, carbon deposits on valves are reduced in air-compressor operation. The New STANOILS separate readily from water—no troublesome emulsions in compressor crankcases.



In Reduction Gears. Because of STANOIL's resistance to acidity and to deposit formation, gear cases of reduction gears remain clean. The oil may be used for longer periods with no danger of excessive wear of gears and bearings.

STANDARD OIL COMPANY (INDIANA) STANDARD

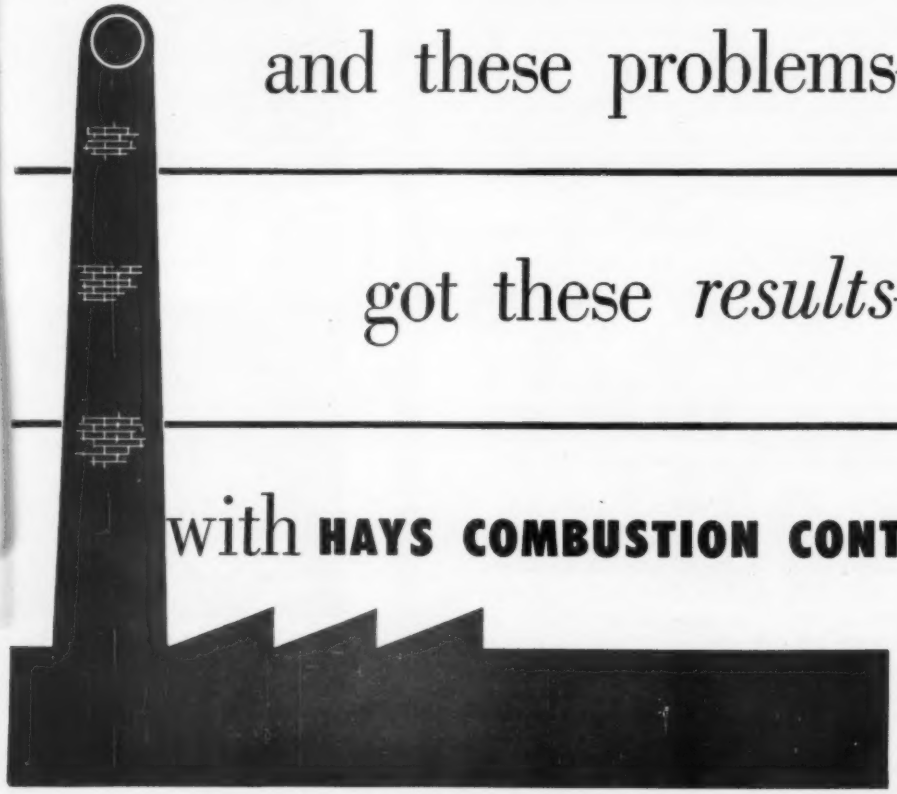
these leading companies →

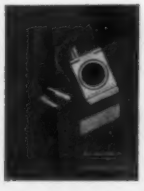
with these conditions {

and these problems →

got these *results* →

with **HAYS COMBUSTION CONTROL**



	AMERICAN TOBACCO COMPANY	SHERWIN-WILLIAMS COMPANY	RAYBESTOS-MANHATTAN COMPANY	BEMIS BROS. BAG COMPANY	SUNSHINE BISCUIT COMPANY
no. of boilers	Three (one stand-by)	Three	Four	Two	One, plus steam generator incinerator
rating	16,500 lb per hr	65,000 lb per hr	19,650 lb per hr	70,000 lb per hr and 80,000 lb per hr	31,500 lb per hr
load	Varies from 40-50,000 lb per hr total fluctuation up to 20,000 lb per hr	75,000 max. each boiler	120,000 lb per hr in winter—70,000 lb per hr in summer	68,000 lb per hr in winter, 60,000 lb per hr in summer. Daily variation 15,000 lb per hr	From 10,000 to 30,000 lb per hr
fuel	Coal	Coal	Coal	Oil and coal	Oil
use of steam	Power and process	Process and space heating	Mostly for process, also for pumps, compressors and heating	Power, process and heating	Process
	1. To recondition or add new boiler 2. Better process load regulation	Combustion efficiency	To get better efficiency. To get more out of boilers due to rising load	Accurate control of pulverized coal and oil firing through wide load swings	To lower costs. Drastic load fluctuations
	(1) "The Hays instruments and controls, through greater efficiency . . . gave us the solution . . . that of increasing steam capacity" and (2) "regulating the steam that goes into process."	"Operating efficiency has been as high as 82%—much of the credit going to the accuracy of (Hays) automatically controlled combustion."	"Our basic reason for installing the Hays control was to obtain better efficiencies. Our aim was more than reached . . . efficiency . . . 79.3%."	"We have made test runs using the Hays automatic combustion control system, bringing the load rapidly up from 8,000 lb per hr to 80,000 lb per hr with excellent results."	"Our management and operating crew are well pleased with the new (Hays) unit, not only because of the low maintenance costs but also because the equipment enables us to keep close watch over our operating costs."
					

compare your control requirements and write for the results story which matches your needs—free on request

THE HAYS CORPORATION *MICHIGAN CITY 7, INDIANA* • Automatic Combustion Control • Boiler Panels •

Hays-Penn Flowmeters • Veriflow Meters and Veritrol • Gas Analyzers • Draft Gages • Combustion Test Sets • CO_2 Recorders • Electronic Oxygen Recorders

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •

Minimum Pressure Drop

SAVES POWER

The beveled vane of an R-S Valve seats firmly against the valve body to produce commercially tight shut-off with metal-to-metal seat. A rubber seat produces drip-tight closure. In the open position the streamlined vane creates a Venturi action. Pressure drop in R-S Valves is low, and they therefore produce substantial savings in pumping costs.

Illustration shows a heavy duty R-S Valve used in the water system to a compressor house. Valve is equipped with diaphragm motor, handwheel control with self-locking worm and gear and declutching mechanism together with outboard bearing for operating shaft with goose neck support.

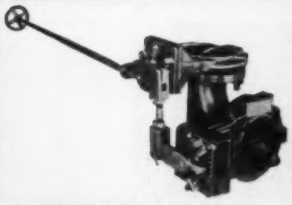
Every R-S Valve is engineered and constructed for rugged service and provided with such safety factors that it will give complete satisfaction in the service for which it is designed. Consult with your local R-S Valve Engineers or write direct.

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.
An S. Morgan Smith Company Subsidiary

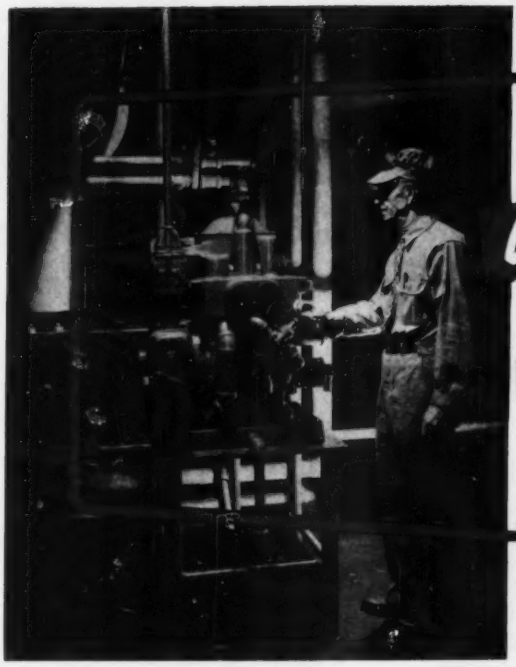
No. 579—6-inch 15-pound Direct Action Float Valve with counter-weight assembly.

No. 628—Solenoid Trip Valve is used for emergency service. The solenoid can be arranged with the counter-weight mechanism to open or close the valve and hold it there in one position or the other. If for any reason the solenoid functions, the latch is tripped, which permits the counter-weight to open or close the valve by gravity. The assembly is suited to shut off the flow or to open a vent and requires manual reset. Can be constructed of any metal or alloy and in various sizes for air, gases, steam, oil, hydraulic and other services.

No. 677—1500-pound Welding End Steel Valve for superheated steam service. A.S.M.E. standards with heavy duty handwheel control.

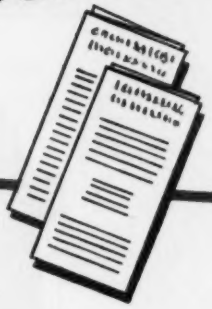


No. 795—Three-inch 3-way Valve Type No. 733 utilizing standard tee and two wafer valves with extended handwheel control.



At Calco Chemical's Power Plant —

DE LAVAL DOUBLE PROTECTION IS TURBINE LIFE INSURANCE



De Laval Oil Purifiers are especially important at the power plant of Calco Chemical Company, for this great plant is completely independent of outside power. The De Laval centrifugal machines, on continuous by-pass, keep the turbine oil free of both of the chief contaminants that tend to cause trouble —***dirt*** and ***water***. Since a perfectly clean lubrication system is the best protection a turbine can have, and since the De Laval machines keep the oil always in a safely clean condition, in truth these centrifugals are a form of "life insurance" for the power plant.

The De Laval centrifugal helps maintain in any oil the properties given it at the refinery. It does not remove oil-soluble additives.

When oil is circulated on continuous by-pass, through De Lavals of proper capacity, it is purified from three to four times daily. The oil never has a chance to become contaminated.

● Write for Bulletin TO-1.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

DE LAVAL

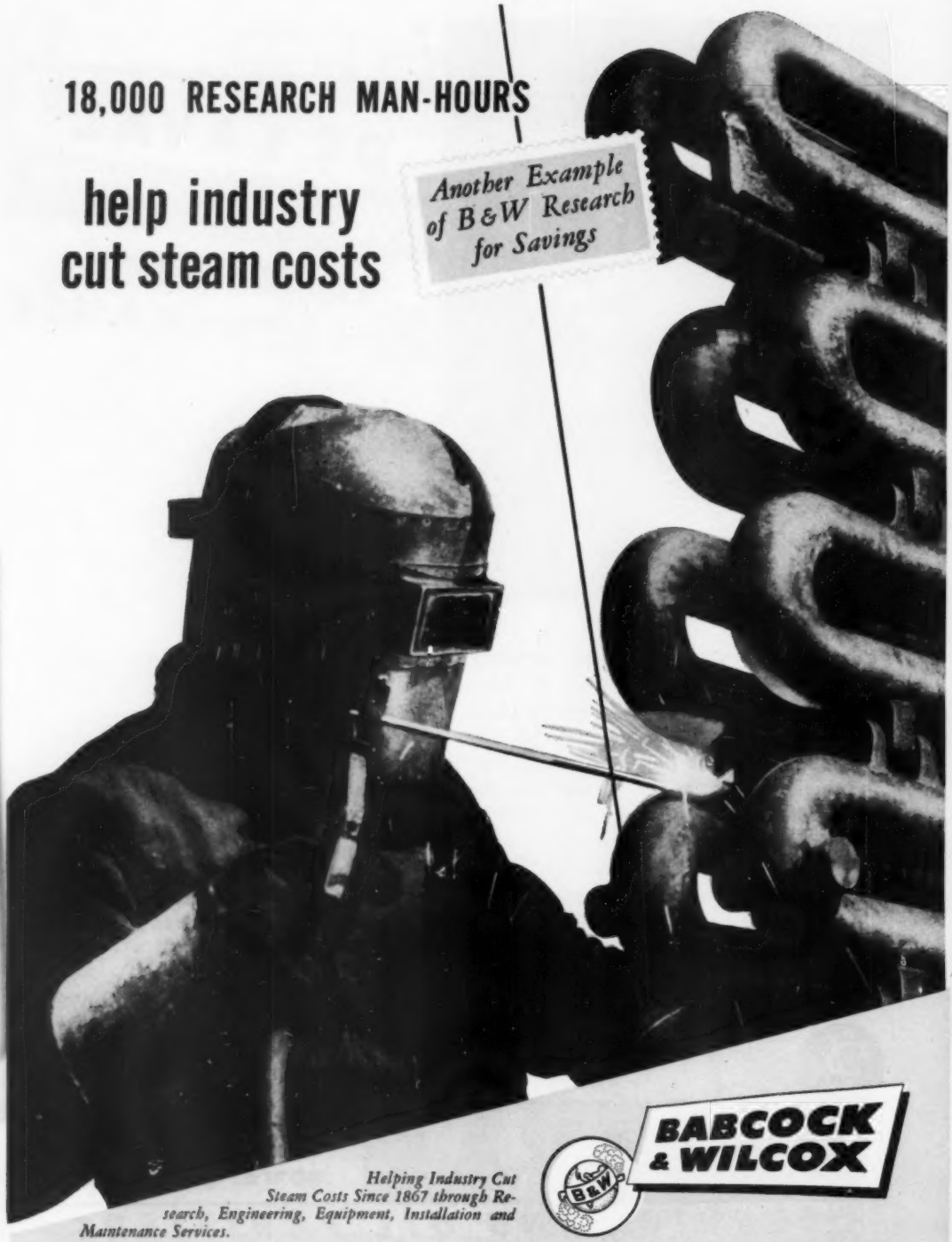
for most dependable power production

LUBRICATING OIL PURIFIERS

18,000 RESEARCH MAN-HOURS

help industry cut steam costs

Another Example of B&W Research for Savings

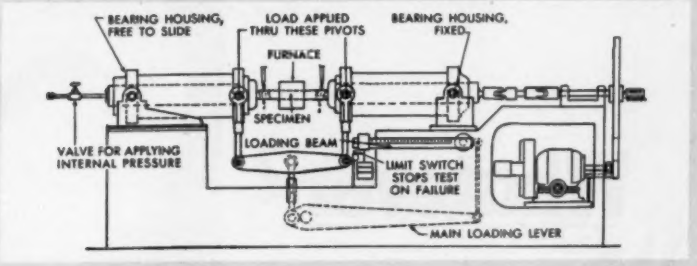


Helping Industry Cut Steam Costs Since 1867 through Research, Engineering, Equipment, Installation and Maintenance Services.

BABCOCK & WILCOX

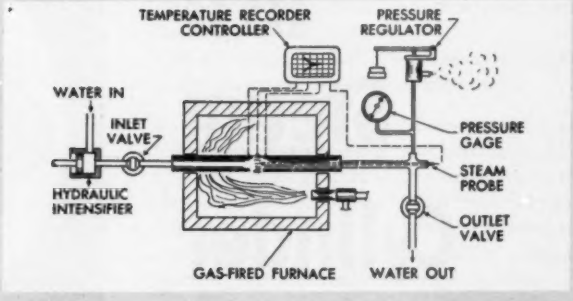
ROTATING BEAM FATIGUE MACHINE

Designed and built by B&W, this apparatus is used to observe fatigue of welded joints under simulated operating conditions: internal pressures to 4000 psi, temperatures to 1400 F, and variable stresses.



CYCLIC QUENCH APPARATUS

Also designed and built by B&W to test effects of repeated quenching on welded specimens at 1050 F and 2500 psi — i.e., actual boiler operating conditions of highest temperature-pressure combination now in service.



Steel—basic in industry—assumes many forms to meet the increasingly severe conditions of modern boiler operation. For example, B&W uses eight or more different steel analyses to obtain optimum dependability, service life, and economy for their high-pressure, high-temperature units.

These Steels—individually, and under conditions each must meet—are stable, tough, flexible, and strong. However, when welded together, they tend to become intractable . . . creep, flow, stretch, warp, harden, crack, and otherwise change at the welded joints to a dangerous and costly degree. B&W is constantly seeking improved methods of welding—to curb these capricious traits of modern alloys . . . and to *help industry keep power costs down.*

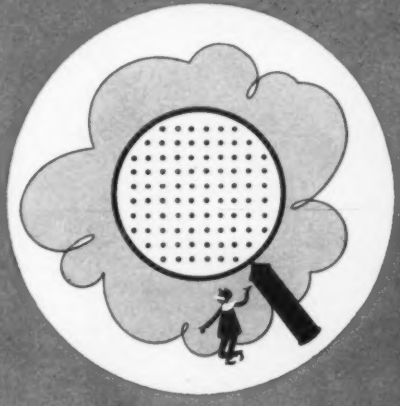
For Example: B&W is continuing a three-year-old project, involving some 18,000 research man-hours, on joining widely dissimilar alloys in tubular form. Findings have already produced new methods of control and new welding techniques that are measurably superior to any used before. They add much to the assurance of dependable B&W boiler service at temperatures to 1050 F and pressures as high as 2500 psi.

This Sort of Creative Research in problems of boiler design and construction is an 80-year-old story at B&W. Perhaps it's just what is needed to bring *your* current steam-generating problem to a profitable solution.

G-5137

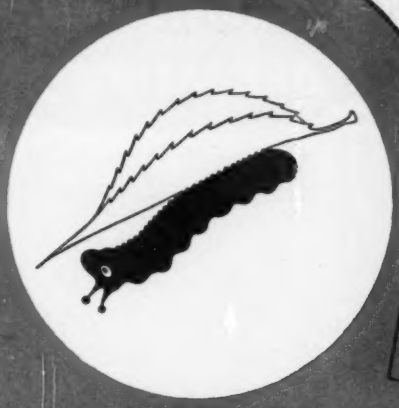
Whatever you need in a Steam Cylinder Oil...

Quick ATOMIZATION



DISTRIBUTION throughout the steam

HIGH TEMPERATURE resistance



ADHESION to cylinder walls and valves

RESISTANCE to washing off lubricated surfaces

Complete SEPARATION from condensate

Sinclair has it!

No matter what your operating conditions—
pressure, temperature, quality of steam; speed, loading;
condensing or non-condensing—
there is a Sinclair Steam Cylinder Oil made expressly
to give the utmost in lubrication satisfaction.

Through proper combinations of steam cylinder stocks and compounding ingredients, Sinclair lubrication technologists have developed a series of steam cylinder oils to fit the operating needs of any installation. There are oils that provide quick atomization . . . persistent adhesion to cylinder walls in the presence of moisture . . . rugged, wear-resisting lubricating films under super-heat . . . or complete separation from condensate where that is the dominating requirement.

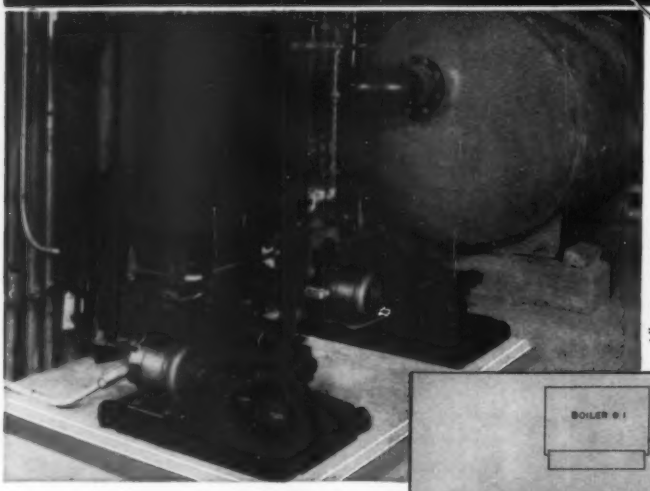
A Sinclair lubrication engineer will help you select the proper oil for your particular service.

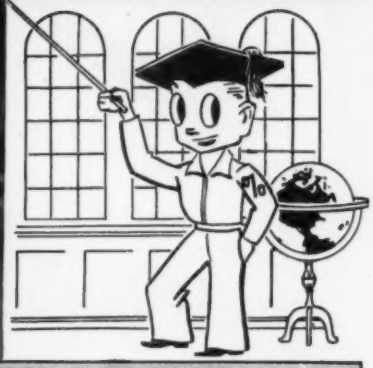
SINCLAIR
Steam Cylinder Oils

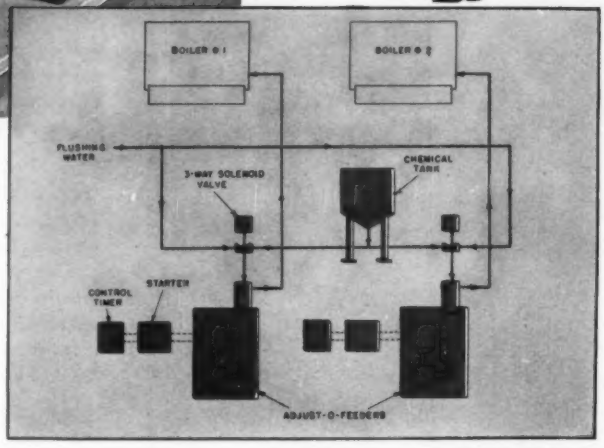
for every steam engine installation

For lubrication counsel see your nearest Supplier of Sinclair Products or write Sinclair Refining Company, 630 Fifth Avenue, New York 20, N. Y.

MAKE YOUR BOILER WATER CONDITIONING A ROUTINE OPERATION!







%PROPORTIONEERS, INC.%

System is Positive . . . Protecting Your Boiler and Reducing Steam Costs

All equipment shown red in photo and flowgram furnished by %Proportioneers, Inc.%

At Oberlin College this %Proportioneers% installation automatically provides correct boiler water treatment, adding the proper chemical in the correct proportion, at the right point, at the right time. Chemical treatment as applied by the %Proportioneers% system offers the advantages of improved heat transmission, fuel savings, and greatly reduced maintenance for every power plant from the largest high pressure installation to the smallest low pressure job. We supply complete chemical feeding systems including metering pumps, with control panels, chemical tanks, dissolvers and all other units required. Let us assume full responsibility for your complete chemical feeding system.

Write for Brochure SM9020 and Bulletin CAT.

No. 3 in a series on boiler water conditioning.

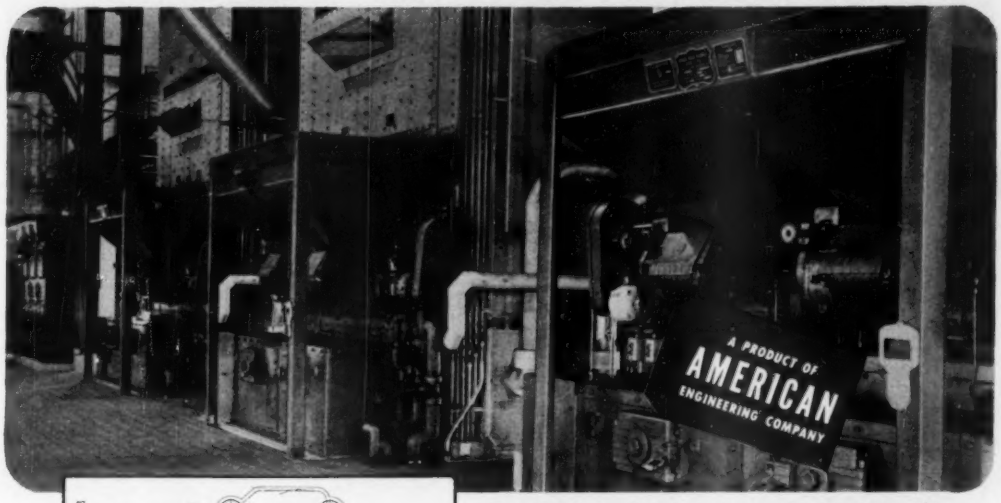
% PROPORTIONEERS, INC. %

Write to %PROPORTIONEERS, INC.%, 385 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

TOP EFFICIENCY FROM LOW AND HIGH ASH COALS

PERFECT SPREAD STOKER



Three AE Perfect Spread 2-feeder, travelling grate Stokers recently installed by a leading pharmaceutical manufacturer in the midwest. The boilers, each with a maximum continuous capacity of 60,000 lbs. per hour are Union "A" Type. Efficiency at normal capacity, 83.4%; at maximum capacity, 82.4%. Consulting Engineer, Austin Company.

In the Boiler Room illustrated, the Perfect Spread Stokers were guaranteed to use coal containing either 13,306 B.T.U. or 11,327 B.T.U. per lb. as fired. These two coals have moisture contents of 4.7% and 10.7%, with ash content of 8.2% and 10.1%, respectively. With either coal, practically the same capacity is available but these Perfect Spread Stokers have done even better than predicted. Five different grades of coal have been used to date . . . and all with top efficiency.

Perfect Spread's unique feeder won't clog on wet coal but feeds uniformly—not in slugs—regardless of moisture content. Its engineered cinder return and adjustable overfire air system give comparable results from either low or high ash coals. Its even feed characteristic insures higher CO_2, freedom from smoke puffs, minimum carbon in the ashpit, and less fly ash. Feeders adjustable from 50 to 7,500 lbs. of coal per hour . . . capacities range from 8,000 to 500,000 lbs. of steam per hour. Mail coupon today for full data.

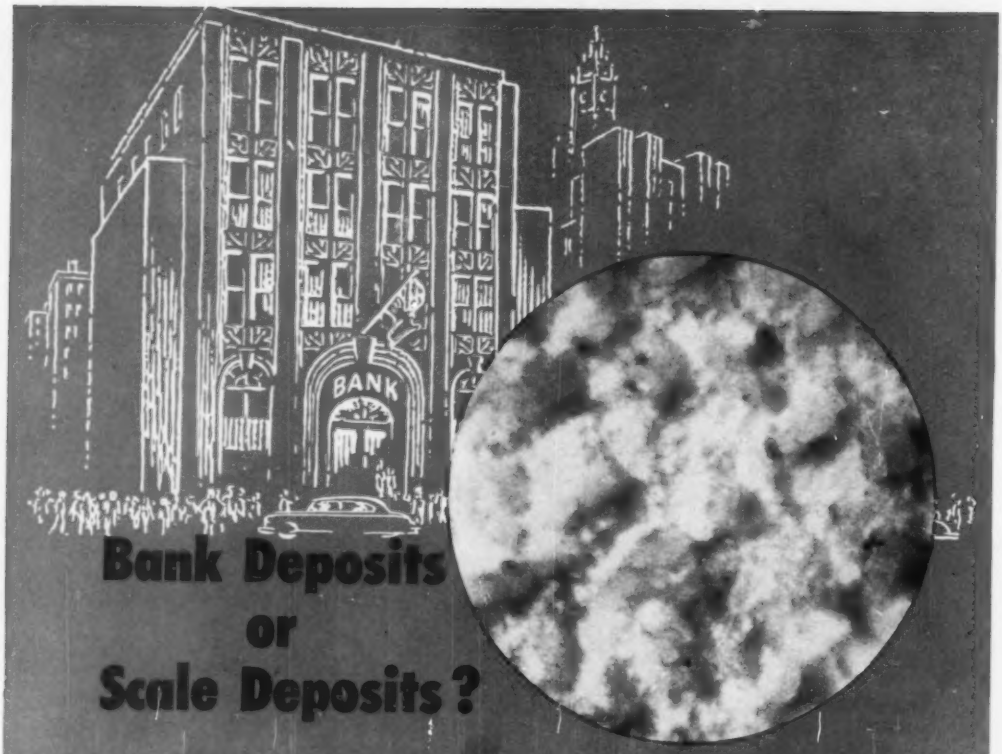
AMERICAN ENGINEERING
COMPANY
PHILADELPHIA 25, PENNA.

AE Products are: Taylor and Perfect Spread Stokers, Marine Deck Auxiliaries, Hele-Shaw and Hydramite Fluid Power, Lo-Hed Hoists, Lo-Hed Car Pullers

American Engineering Company
2408 Aramingo Ave., Philadelphia 25, Pa.

Gentlemen: We are interested in saving fuel dollars. Kindly send booklet giving full information about Perfect Spread Stokers.

Name ..... Title .....
Company .....
Address .....
City ..... Zone ..... State .....



Bank Deposits or Scale Deposits?

Scale and sludge deposits, carryover, corrosion and high blowdown all result in high boiler operating and maintenance expenses that add to the cost of doing business.

These problems and costs can be eliminated by proper water treatment and controls . . . based upon the conditions that exist in *your* plant. That's where Drew Water Treatment Service starts. And it includes *all* the corrective and preventive measures required for efficient operation.

Drew Service is *specialized* service applied to your specific operating problems . . . designed to reduce your operating expenses. If you'd like to cut costs—as others have—consult the Drew Engineer or write for information.

POWER DREW CHEMICALS

Power Chemicals Division

E. F. DREW & CO., INC.

15 East 26th Street, New York 10, N. Y.

DREW PRODUCTS

Nationwide Service in Boiler Water and Cooling Water Conditioning

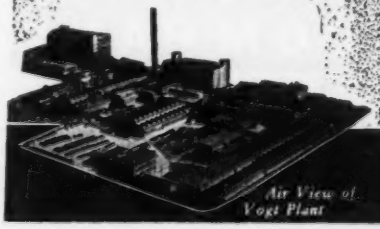
it's NEW!

Vogt
BLUE BOOK
of the Drop Forged Steel
Valve and Fitting Industry

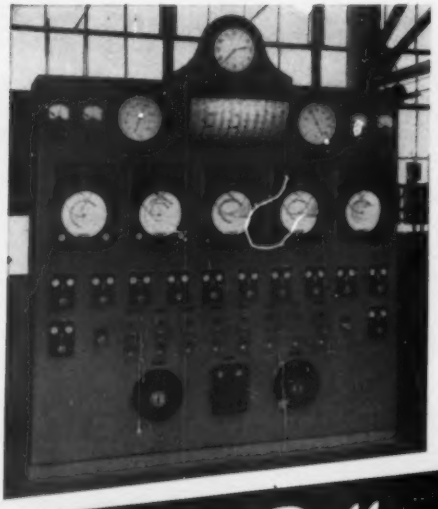
Keep up-to-date with this 400 page Catalog . . . it's chock full of new and improved *drop forged steel* Valves, Fittings and Flanges designed to meet every modern piping need for high or low pressures and temperatures in process work.

Be Safe and Sure . . . Use Vogt *drop forged* in all oil, water, steam, air, gas and refrigeration services.

Write for a copy of Catalog F-9
on your Company letterhead


Air View of Vogt Plant

HENRY VOGT MACHINE CO., Inc.,
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES: New York, Chicago, Cleveland, Dallas, Philadelphia, St. Louis, Charleston, W. Va.



This Bailey Boiler Control Panel in a mid-western industrial plant saves fuel and insures safe operation of a 100,000 lb per hr, 175 psi, sat., pulverized coal and gas-fired boiler.

What's Your Control-Dollar Efficiency?

Control-dollars frequently bring annual investment returns of 100% or more. When you buy adequate, well-applied steam plant controls, you increase your dollars' ability to work usefully for you.

That's where Bailey can help: Bailey Controls can give you a better control-dollar efficiency. Here's why:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service — conveniently located near you.** Bailey Meter Company's sales-service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better control-dollar efficiency—for more power per fuel dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-112-1

BAILEY METERS

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

"DUST STORM". Abrasive dusts sprayed on the Type E, while operating at full speed, for extended periods, fail to impair operation. In these tests, none of the abrasive entered the bearing housing . . . governing and overspeed-trip mechanisms continued to operate freely.

Defies dust and dirt

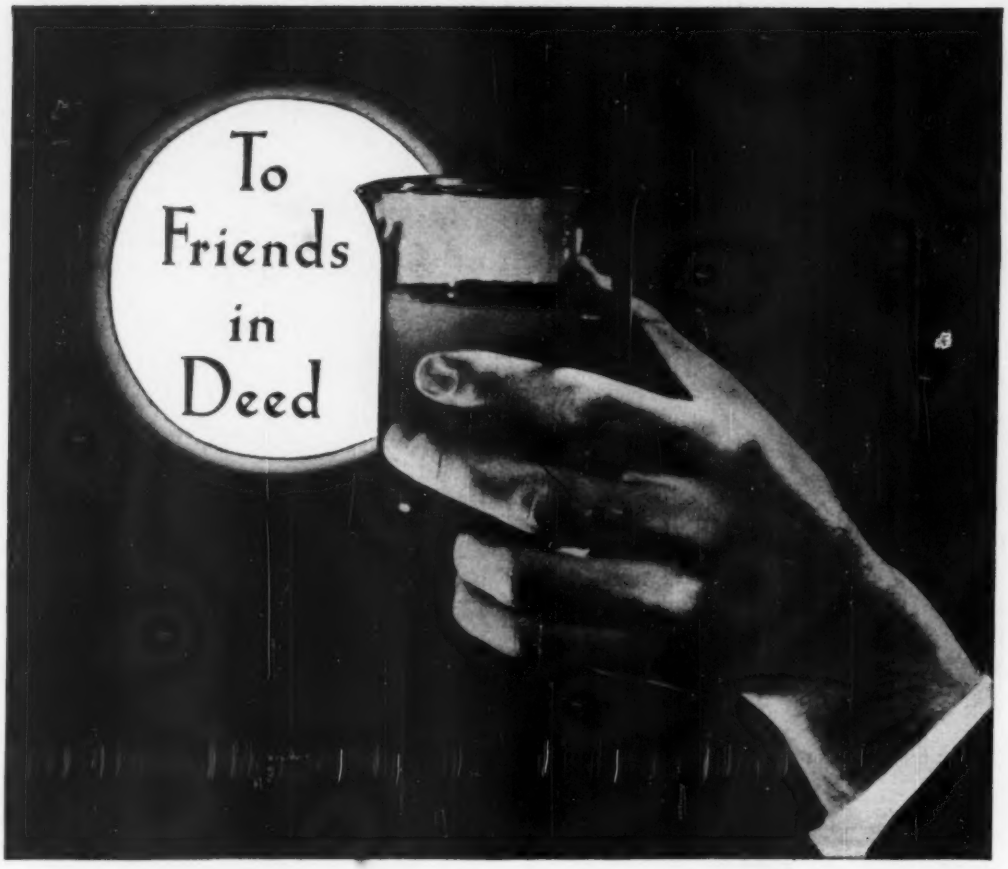
Depend on the general-purpose Type E Turbine for the kind of service you want . . . whenever and wherever you want it.

Prolonged exposure to abrasive dusts fails to more than dirty up the outside casing. Type F construction keeps foreign matter out, and eliminates close-sliding fits. Materials used in construction resist corrosion and erosion . . . you get a turbine that's *rugged.*

Investigate these, and all the other vital features wrapped up in industry's *standard* turbine . . . the Type E. Get complete information from your nearby Westinghouse office, or write for your copy of the Type E Turbine Book, B-3896. Westinghouse Electric Corp., P. O. Box 868, Pittsburgh 30, Pa.

J-50500-A

Westinghouse
TYPE E
Turbines



SEVERAL months ago a basic chemical shortage, created by strikes, caused Nalco a great deal of difficulty in supplying adequate quantities of water treatment chemicals to established users.

Uniformly, Nalco System users displayed a wonderful cooperative spirit and understanding patience during this trying period.

We wish to take this public means of thanking and expressing our pride in our friends in deed—and to note with satisfaction that not a single shutdown was reported as being necessary because of an inadequate supply of Nalco chemicals.

With the immediate prospect of greater military and defense uses of many chemicals, it is particularly reassuring to know that Nalco and Nalco System users have a fully demonstrated ability to work closely together in turning adversity into success.

NATIONAL ALUMINATE CORPORATION

6224 West 66th Place • Chicago 38, Illinois

In Canada: Alchem Limited, Burlington, Ontario

THE *Nalco* SYSTEM . . . Serving Industry through Practical Applied Science

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

PUMPS, COMPRESSORS

101 **For Controlled Volume Pumping**—Sixteen-pp Bulletin 450 presents company's air-cylinder powered chemical pumps for controlled volume pumping at constant speeds, at proportional rates, at high pressures, and for other applications. Illustrated with photos, sectional drawings. Gives design details; diagrams and describes typical feed systems available; illustrates auxiliary equipment. Also includes air consumption and capacity-pressure tables. Milton Roy Co.

102 **Chemical Pumps**—Company's Type MR pumps for boiler water treatment, for controlled volume applications, for pumping at any pressure, and for handling corrosive chemicals are the subject of 4-pp Bulletin 1032. Design features are described and illustrated and center spread is devoted to capacity-pressure selection tables. Dearborn Chemical Co.

103 **Centrifugal Pump**—Bulletin 720.4 8-pp, presents a single-stage, open-impeller type centrifugal pump, Bronze fitted, that's especially designed for general water service, irrigation, circulation, slurries, transfer and factory wastes but is applicable for other services. Illustrated with photos and cutaways, shows how pump is constructed, gives specifications, bronze analysis, performance curves, dimensions. Goulds Pumps, Inc.

104 **Rotary Pumps**—The operating principle, special advantages, construction features and range of applications of standard, heavy duty and special rotary pumps are explained in illustrated Bulletin 51-S, 8 pp. Includes dimensional data, specifications. Viking Pump Co.

105 **Motor Driven Compressors**—Bulletin 726-5, 28 pp, is devoted to company's O-CE horizontal duplex motor driven compressors featuring anti-friction roller bearings throughout. This and other advantages are described and construction and design details explained and illustrated. Bearing removal by oil injection method is discussed, as is five-step regulation. Illustrated with photos, large cutaway drawing. Chicago Pneumatic Tool Co.

106 **Modernized Compressors**—Eight-pp Form 3128 describes and illustrates a gas-engine driven compressor in 330 and 440 hp sizes—an improved and modernized version of company's well known XVO compressor. Improvements incorporated in the new compressor, the SVG, are explained in detail and design features illustrated by cutaway drawings. Full specifications included. Ingersoll-Rand Co.

VALVES, PIPING

107 **Popular Steel Valves**—Condensed Catalog 104, 28 pp, describes and illustrates the most widely used of company's cast and forged steel valves and the data presented for these valves is complete. Those listed are chiefly in the basic steam pressure classes—150 to 2500 lb—and include globe and angle, gage, instrument, hydraulic and relief types, also strainers, and check, gate, non-return and blow-off valves. Explains special design features of the lines, gives construction details, dimensions, ratings, material specifications. Edward Valves, Inc.

108 **Valves, Fittings and Flanges**—Catalog F-9, just released, is a 400-pp. permanently bound reference book on drop forged steel valves, fittings and flanges for practically all piping needs at high and low pressures and temperatures. Provides not only ordering information on company's complete line, but also much helpful engineering and application data, and includes a section on products for refrigeration service. Fully illustrated with photos and drawings, book is well-indexed, compiled for easy use. Available to qualified power engineers, please give your title. Henry Vogt Machine Co.

109 **Automatic Valves**—Bulletin 290, 4 pp, presents a cross section of company's line of valves and introduces two new ones—an automatic recoating relief valve and a large pressure reducing and regulating valve. Fully illustrated, tells what each valve is designed to do and where it should be used. Includes dimensions. A. W. Cash Valve Mfg. Corp.

110 **Where Lightweight Pipe Is Used**—Bulletin 507, 4 pp, shows typical applications of company's Lockseam Spiral-weld pipe in the construction, dredging, materials handling, mining, oil, paper mill, power and sewage disposal fields. Includes data on fittings, flanges, connections, and pipe specifications from 4 to 30 in. dia. Naylor Pipe Co.

MECHANICAL POWER TRANSMISSION

111 **Variable Speed Control Simplified**—Bulletin 700 contains some 40 pp of descriptive, application and engineering data on variable speed pulleys and selective speed transmissions. Includes many photos and drawings and detailed information showing how old and new machines can be easily equipped with efficient speed control. Lovejoy Flexible Coupling Co.

112 **More Flexible Speed Reduction**—Bulletin A001, 12 pp, presents company's single-reduction Torque-Arm speed reducer, explaining its important advantages. This unit for output speeds of 115 to 330 rpm and capacities to 27 hp is described as offering a more flexible and more economical means of speed reduction. It consists of a reducer with fixed ratio driven by a motor through a V-belt drive; construction and design details are illustrated and described. Includes dimensions, full tabular data for selecting proper size reducer. Dodge Mfg. Corp.

113 **Worm Gear Speed Reducers**—Emphasizing the dependability and long-run economy of these reducers, this 8-pp bulletin presents some installation case histories, pictures installations currently in use which date back to 1923, and describes and illustrates some new models, including vertical drives, standard units and worm gear sets. The Cleveland Worm & Gear Co.

Use this CARD for information on ADS and NEW PRODUCTS also

FIRST CLASS
PERMIT No. 353
Sec. 34.9, P. L. & R.
CHICAGO, ILL.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

POSTAGE WILL BE PAID BY—

POWER ENGINEERING

110 S. Dearborn

CHICAGO 3, ILLINOIS

PLEASE PRINT OR TYPEWRITE

FEBRUARY, 1951
Card Void in 6 months

POWER ENGINEERING

Please have the manufacturers send me without obligation information or bulletins indicated by the following numbers.

.....

.....

.....

.....

.....

Your Name.....

Your Title.....

Your Company Name.....

Company Address.....

City.....State.....

(If you prefer delivery at your home also fill below)

Home Address.....

City.....State.....

Also, use this card for more information on advertised products.

114 **Drive Manual**—This helpful 48-pp book on the Uni-Pull drive enables a power engineer to select, without calculation, the correct width, thickness and length of flat leather belt, together with pulleys of correct dimension, both driver and driven, to transmit power from a motor of a given horsepower and speed to a machine to be operated at a given speed. Table are also included for selecting belt tension controlling motor base for motors built in standard NEMA frames. Also contains basic horsepower rating data for flat leather belting, recommended minimum pulley diameters, other drive data. American Leather Belting Association.

MATERIALS HANDLING

115 **For Economical Unloading**—A car shaker for unloading granular material from hopper-bottom gondola cars is described in Bulletin 07B7221A, 4 pp. Construction features of the shaker are given along with specifications and a cross section through vibrating mechanism. Shows how shaker is designed to save time and money and eliminate danger to operating personnel. Allis-Chalmers Mfg. Co.

116 **Super Coal Conveyor**—This folder describes a coal-and-coke-handling conveyor said to incorporate most modern design features. Discusses belt, frame, pulleys and other construction details; gives dimensions. Also illustrates radial storage possible with this unit. Conveyor Div., A. B. Farquhar Co.

117 **Conveyor and Elevator Belts**—This 26-pp collection of catalog sections illustrates in detail all major parts used in construction of company's conveyor and elevator belts. Describes belt features, explains why increased service life and decreased maintenance are possible. The B. F. Goodrich Co.

118 **Coal Scale**—Twelve-pp Bulletin 6250 describes a pressure-tight, automatic coal scale, its construction and operation. How the beam system, electrical components and linkages are protected from exposure to coal dust, explained and illustrated. Some typical installations are pictured. Richardson Scale Co.

INSTRUMENTS AND CONTROLS

119 **Electric Master Control System**—The Telemaster, introduced in 8-pp Bulletin 1100, is a new method of providing an electronic link between master and running regulators of a combustion or process control system. Designed to solve distance problems arising in centralization of controls for modern equipment, to permit complete freedom of control centralization, simplified and smaller control panels, to eliminate transmission lags and panel piping, to give application flexibility and reduced maintenance. Based on principle of a-c Wheatstone bridge, this control system, its interchangeable parts, sub-panels mounted on benchboard, automatic and manual controls are described in detail. Republic Flow Meters Co.

120 **Electronic Relay**—Specification Sheet 194, 4 pp, describes and illustrates an electronic positioning relay with automatic reset. Besides general specifications, discusses operating principles. Also describes large and small proportional control motors. Industrial Div. Minneapolis-Honeywell Regulator Co.

121 **For Centralized Control**—Bulletin 109, 4 pp presents the new, compact Mini-Line equipment described as ideally suited to control board arrangement which concentrates vital operating information and controls for one or more boilers, turbines or process units before a single operator. Describes and illustrates vertical-scale indicator units, selector valve and remote manual relay. Includes dimensions. Bailey Meter Co.

122 **New Pyrometers and What They Offer**—Bulletin GEA-5534, 8 pp, introduces new equipment for the indication and control temperature and protection of heat process equipment. Describes and pictures various indicating, controlling instruments and protectors, stresses accuracy and sensitivity. General Electric Co.

123 **Safety Switch**—Bulletin 7800, 2 pp, introduces company's new Hi-Level Switch, a safety switch working on compressed air and requiring no electrodes or floats. Explains and illustrates how it functions as an effective audible or visual alarm switch independent of other controls, tells applications. Automatic Control Co.

WATER CONDITIONING, TESTING

124 **Corrosion Inhibitor**—How company's 160 Series corrosion inhibitor acts by neutralization and surface adsorption to control corrosion of steam and condensate lines is told in 2-pp Bulletin 25X7582. This inhibitor, a mixture of organic amines selected according to volatility characteristics required by each steam condensate system, is a colorless liquid containing no ammonia. Its use is suggested where expenditures for deionizers or sodium-hydrogen zeolite softeners are not justified. Allis-Chalmers Mfg. Co.

125 **For Conductometric Determination of Solids**—A quick and simple method for determining solids content of boiler water or condensate is explained and illustrated in Bulletin 2RE50, 4 pp. The test procedure for boiler water utilizes company's conductivity meter in conjuction with a cell, dial thermometer, conductivity cylinder and reagent. Samples may be tested at any convenient temperature. A price list on testing equipment is included. Hall Laboratories, Inc.

FUEL OILS, LUBRICANTS

126 **Fuel Oil Additives**—Bulletin 53, 4 pp, presents three fuel oil additives—a single all-purpose treatment, an additive for prevention of sludge and corrosion and one for corrosion control alone. Cites some industrial reports on the use of the multi-purpose additive. National Aluminate Corp.

127 **New Horizons of Grease Research**—Power engineers interested in knowing what's being done in the laboratories toward learning more about grease itself as well as improving lubricants, will enjoy reading Vol. 36, No. 12 of Lubrication, a technical house organ. Among subjects touched upon in the 8-pp article are the use of the electron microscope and other instruments. The Texas Co.

FEEDERS, CHLORINIZERS

128 **Chemical Feeders**—Catalog 50T8, 4 pp, describes and illustrates several models of chemical feeders specially designed for automatically feeding reagents into boiler feed water. Explains and illustrates how feeders are adjustable to inject any desired proportion of chemical into boiler water. Includes price list. Manuel Div., Frontier Industries.

129 **Small Weighing Feeder**—Eight-pp Bulletin 35-G5 presents a small gravimetric chemical feeder for dry materials, stressing its non-flooding feeding mechanism, capacity ranging from a few cubic inches to 3 cfm and feeding range of 100 to 1. Explains operation of feeder as well as describing component parts. Curves show limits of accuracy, and illustrations include photos of parts, dimension drawings and pictures of installations. Omega Machine Co.

130 **High Capacity Chlorinizer**—Bulletin 940-G27, 4 pp, describes a high capacity visible flow chlorinizer designed to meter chlorine gas accurately at rates of 100 to 6000 lb per 24 hr. Lists features and

(Continued on page 142)

Use this CARD for information on ADS and NEW PRODUCTS also

PLEASE PRINT OR TYPEWRITE

FEBRUARY, 1951
Card Void in 6 months

POWER ENGINEERING

Please have the manufacturers send me without obligation information or bulletins indicated by the following numbers.

_____
_____
_____
_____
_____

Your Name_____

Your Title_____

Your Company Name_____

Company Address_____

City_____ State_____

(If you prefer delivery at your home also fill below)

Home Address_____

City_____ State_____

Also, use this card for more information on advertised products.

FIRST CLASS
PERMIT No. 353
Sec. 34.9, P. L. & R.
CHICAGO, ILL.

BUSINESS REPLY CARD
No Postage Stamp Necessary If Mailed in the United States

POSTAGE WILL BE PAID BY—

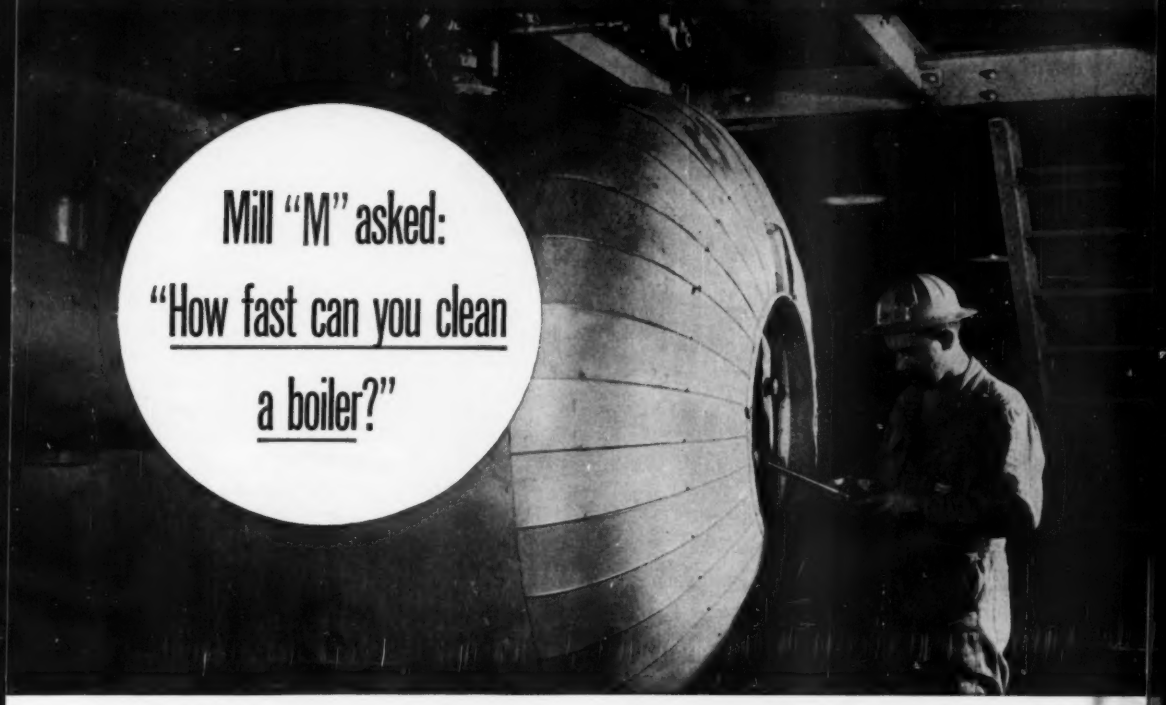
POWER ENGINEERING

110 S. Dearborn

CHICAGO 3, ILLINOIS

DOWELL SERVICE

CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS



Dowell Service cleaned the internal surfaces in 10 hours!

This was the case of a boiler generating 350,000 pounds of steam per hour with an operating pressure of 1250 p.s.i. In ten hours Dowell Service removed an estimated 1,000 lbs. of deposits which were causing tube failures. The boiler was back on the line the next day.

What is Dowell Service? It is simply the application of chemistry to the problem of removing deposits from heat exchangers, water lines and all kinds of process equipment. Dowell engineers fill the equipment with liquid solvents which reach wherever steam and water flow and are designed to dissolve and disintegrate the deposits efficiently and quickly. Dismantling is not necessary.

Somewhere in your plant there is a job that can be done *faster, better, more economically* by Dowell Service. Let an experienced Dowell Service Engineer help you with your maintenance planning. No obligation, of course.

Other recent Dowell jobs:

Entire Piping Systems of two college dormitories cleaned of scale.

•

Three Formaldehyde Contact Towers and Reboilers cleaned and restored to designed operating efficiency.

•

Six Black Liquor Evaporators cleaned for paper company. Deposits removed from vapor and liquor sides in one operation.

CALL

DOWELL INCORPORATED · TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

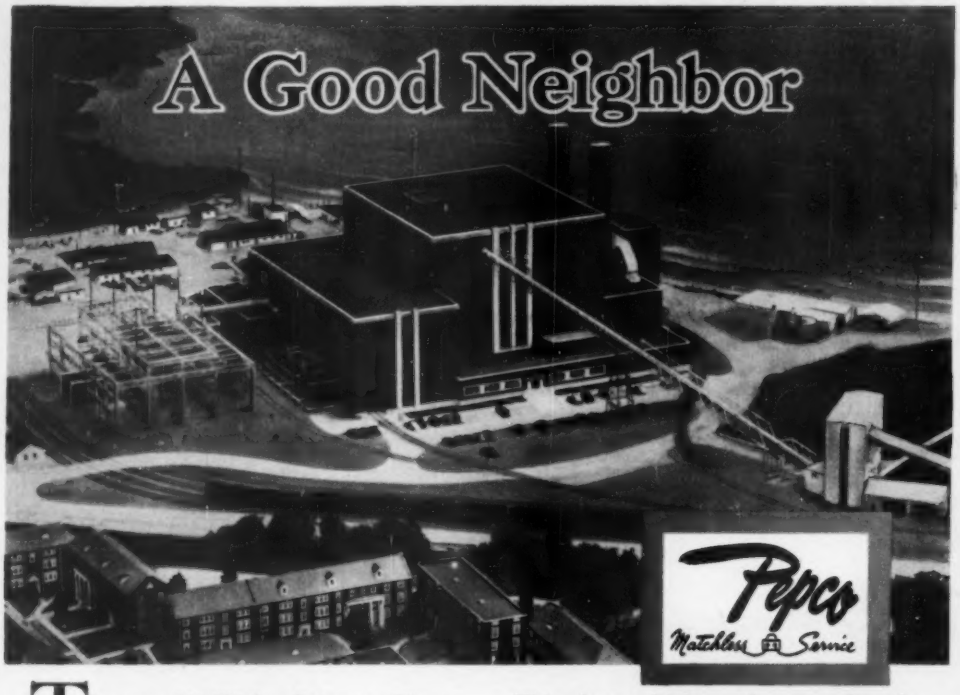
New York 20	Buffalo 2	Kansas City 8	Mt. Pleasant, Mich.
Boston 16	Cleveland 13	Wichita 2	Hamilton, Ohio
Philadelphia 2	Pittsburgh 19	Oklahoma City 2	Charleston 27, W. Va.
Baltimore 18	Detroit 2	Houston 2	Salem, Illinois
Wilmington 99	Chicago 2	New Orleans 12	Borger, Texas
Richmond 19	St. Louis 8	Ft. Worth 2	Midland, Texas
Jacksonville	Indianapolis	Shreveport 69	Wichita Falls, Texas
Atlanta	Louisville	Anniston, Alabama	Lafayette, La.

Long Beach, Oakland, Casper: Dowell Associate—International Cementers, Inc.

DOWELL

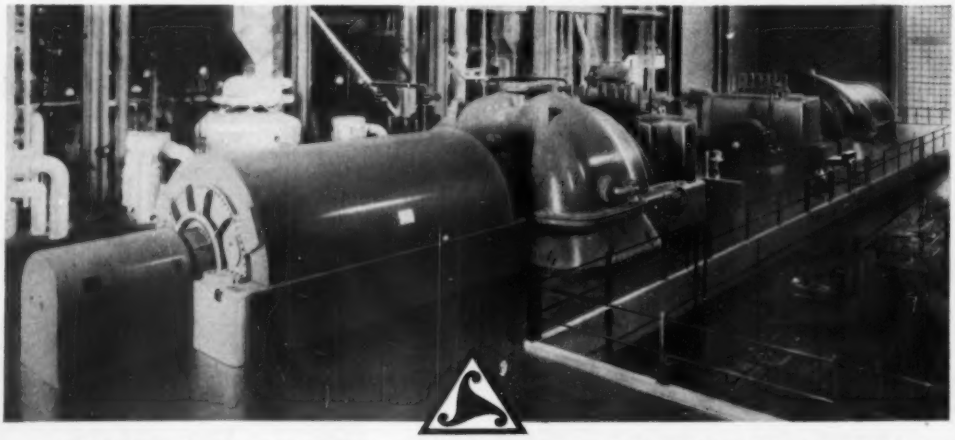
SERVICE ORGANIZATION

A Good Neighbor



The new 160,000 kw Potomac River Station of Potomac Electric Power Company was designed to live in a residential neighborhood adjacent to the National Capitol. The architecture is in harmony with near-by apartments.

This plant, which supplements the other generating facilities of the Company in serving the District of Columbia and surrounding territory, was designed and constructed by Stone & Webster Engineering Corporation.



STONE & WEBSTER ENGINEERING CORPORATION

SUBSIDIARY OF STONE & WEBSTER, INC.

USKORONA

can't be harmed by ozone or dampness

USKORONA SPLICING COMPOUND
UNITED STATES RUBBER COMPANY
US
TRADE MARK
3/4 IN. WIDE
30 FT. ROLL
OZONE AND MOISTURE RESISTING COMPOUND
Uskorona combines maximum resistance to OZONE and MOISTURE with high tensile strength, elongation and dielectric resistance. Fuses quickly without heat or pressure and makes PERFECT SPLICES.
MADE IN U.S.A.
United States Rubber Company

United States Rubber Company research engineers developed USKORONA to eliminate the problem of corona (ozone) deterioration.

Today USKORONA is the only tape that is both moisture and ozone resistant. In a test of four of the leading brands, USKORONA was the only tape to withstand the 4-hour corona exposure. To be extra sure, USKORONA was exposed for 500 more consecutive hours and still showed no signs of corona deterioration.

With such evidence, no wonder USKORONA is used by leading power companies for splices, joints and other underground connections. For more information about moisture and ozone resistant USKORONA, write to the...

A QUALITY PRODUCT OF

U.S. RUBBER
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

TAPE DEPARTMENT • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

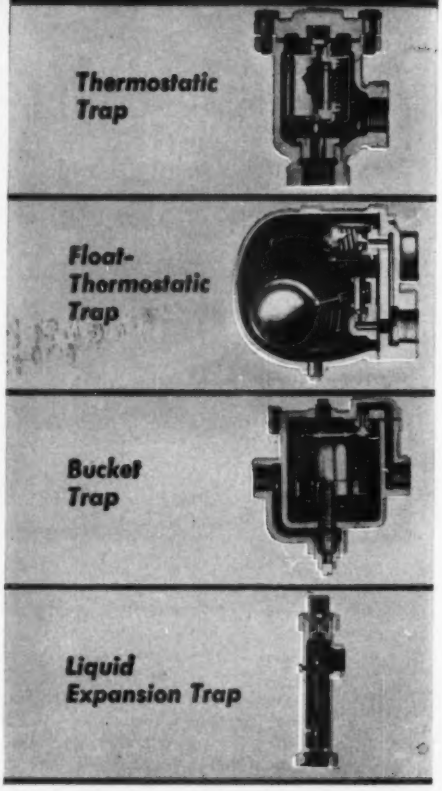
WOULD YOU PLAY A TOURNAMENT *with one club?*

But on the golf course you can see the results. In steam hook-ups on the other hand, bad performance may go undetected for years, even though the traps apparently are working properly.

If you are in competition, it is certain that you cannot get the lowest fuel costs and highest production rates from steam heating and process equipment by "standardizing" on one type of steam trap for all purposes in your plant.

The four principal types of Sarco steam traps are illustrated at the right. They are available in a wide range of sizes and steam pressures and each has a specific function. The trick is to get the right trap on every steam job and every steam line in your plant. This can be done by calling in the Sarco Representative near you, or by asking for Sarco Catalog No. 1600 which gives recommendations for trapping all kinds of equipment, both indoors and out.

STEAM TRAPS ARE LIKE THAT...

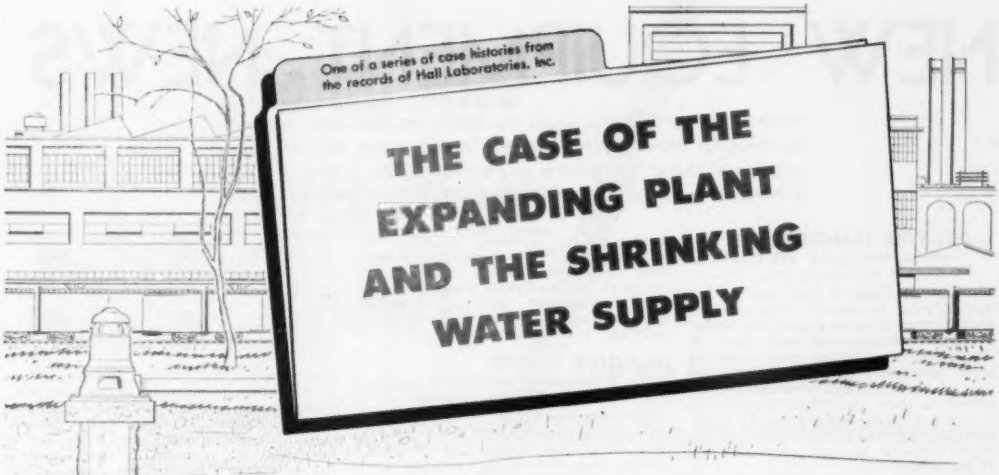


312

SARCO SAVES STEAM

SARCO COMPANY, INC.
Represented in Principal Cities
Empire State Building, New York 1, N. Y.
SARCO CANADA, LTD., TORONTO 5, ONTARIO

IMPROVES PRODUCT QUALITY AND OUTPUT



One of a series of case histories from the records of Hall Laboratories, Inc.

THE CASE OF THE EXPANDING PLANT AND THE SHRINKING WATER SUPPLY

This midwestern manufacturing plant was ready to expand—but water supply was running so low that failure to meet even existing requirements seemed imminent. The obvious answer seemed to be more wells, so an option was taken on land for a new well field.

Top management, however, was not satisfied with the 'obvious' answer, so, before making the additional investment, they called in Hall Laboratories.

Hall engineers first studied water usage. By solving a stubborn slime problem which had made it necessary to flush condensers with fresh water every day, they saved 60,000 gallons per day. Better synchronization of supply and demand eliminated overflow from storage tanks, and use of waste water instead of fresh wherever possible resulted in further savings. These and other measures which are gradually being put into effect are *reducing water consumption* 50%—bringing current requirements safely within the supply which had been available.

This still left the problem of providing for the proposed plant expansion, so Hall engineers next went to work on the wells. Acidizing had been used previously, with small success, but Hall engineers used a new and inexpensive well cleaning method which cleans out clays and other particles not removed by acid. With this method they *doubled* well capacity, increasing the average from 400 gpm to 800 gpm. At the same time, drawdown was greatly *reduced*.

Result: No investment for new wells; ample capacity for all present needs; and plenty of reserve capacity for the planned expansion.

For more information about Hall Plant-Wide Water Service, and particularly in regard to this new and effective method of restoring the capacity of wells, just fill in and mail the coupon.

HALL LABORATORIES, INC.

(A SUBSIDIARY OF HAGAN CORPORATION)

CONSULTANTS ON BOILER WATER CONDITIONING;
PROCUREMENT, TREATMENT, USAGE AND DISPOSAL OF INDUSTRIAL WATER

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.
Please send me your bulletin:
☐ Your Most Important Raw Material ☐ Let's Consider Your *Whole* Water Problem

Name_____

Position_____

Company_____

Street & Number_____

City_____ Zone_____ State_____

PE-2

NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 49-50.

1—DRY-TYPE TRANSFORMERS

Hermetically sealed, with Class B insulation, are lower in price

The use of Class B insulation is responsible for the lower prices of these transformers. Company's previous sealed dry-type transformers with Class H insulation were 20 per cent higher in price than open-type units; these are only 10 per cent higher. Tests are reported to show that Class B materials in a nitrogen atmosphere can be satisfactorily operated at the 180 C temperature formerly assigned only to Class H materials.

These transformers are available in ratings through 1500 kva and 15,000 v and can be supplied with metal-clad switchgear for load center installations or with network protector and high-voltage switch.

Expected to broaden the application of the dry-type transformer, the new hermetically sealed units are nitrogen filled and can be installed indoors without fireproof vaults, or outdoors, where there is no exposure to lightning, or even underground, according to manufacturer. Transformer and Allied Product Divs., General Electric Co.

2—EXPLOSION-PROOF METER

For indicating presence of flammable or explosive gases

By making this portable instrument explosion proof, company engineers point out that they have eliminated the danger of a spark from it igniting a dangerous air-vapor mixture. According to them, the meter is being enthusiastically received by fire marshals, police officials and insurance inspectors.

An easily-handled instrument, it weighs only 6 lb, is 5½ in. in dia and 6½ in. high. Besides the "on" and "off" switch the only controls are a voltage check knob and a zero setting knob. Lor-Ann Instrument Co.

3—MECHANICAL SEALS

For rotary shafts come in standard designs, wide range of materials

With these seals sealing is effected by leakless and positive contact between lapped metal-to-carbon or metal-to-metal mating surfaces, company explains; one of these elements rotates with the shaft and the other is stationary. The stationary element doesn't contact the shaft. Selection of design and materials depends on intended service. The Garlock Packing Co.

4—MOTOR STARTER

Is designed to protect both operating personnel, connected machine

With ratings of 600 v, 7½ hp polyphase, 5 hp single phase; or 220 v, 1½ hp d-c, the Motor Watchman Class 10-100-S1 starts, stops, and provides overload protection for single phase, polyphase and d-c motors. Personnel protection features include the self-indicating handle, interlocked cover to prevent opening unless starter is "off," and safety latch to lock starter "off" during servicing.

Motor protection is provided by the quick-make, quick-break, over-center toggle mechanism, De-ion arc quenching, and bimetallic disc-type thermal overload relay. Starter has straight-through wiring, Bonderized enclosure. Westinghouse Electric Corp.

5—ALUMINUM PAINT

Has silicone base and offers extra high resistance to heat

Heat-Rem H-170 is capable of withstanding temperatures to 1700 F, according to manufacturer, and it fuses with surface metal upon application to form a bright, elastic finish that's resistant to moisture, corrosion, mild acids, alkalis and industrial fumes.

This paint is said to set in 4 hr and dry completely overnight on hot surfaces. It is suggested for use on heat lines, condensers, compressors, engine heads, exhaust manifolds and industrial equipment previously regarded as unpaintable because of temperature limitations. It is packaged in quart, gallon and 5-gal cans. Speco, Inc.

6—TURBINE GENERATORS

High speed, compact and streamlined units in 500 to 7500 kw ratings

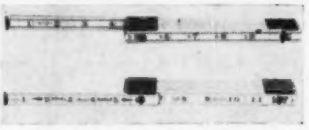
Generators in the WA Series are multi-stage, all-impulse, steam turbine driven units. They are designed to operate with economical regenerative feedwater heating cycles and also be tied-in thermodynamically to provide a steam-power balance where low pressure process steam is utilized. Governor and regulating characteristics provide for paralleling with existing units and tie-lines.

The WA Series design incorporates three-bearing unit construction, housing type generator and direct-connected exciter construction. Allis-Chalmers Mfg. Co.

7—ENGINEERS' RULES

In two new styles, offering double- and single-edged graduations

One of the two wood folding rules recently announced by this manufacturer is the Royal Eagle 610 which has

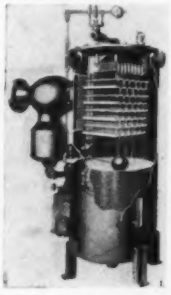


double-edged graduations. It is marked in sixteenths of an inch on the outside and in tenths and hundredths of a foot on the inside. It costs $1.75. The single-edged graduated rule is the All American 410, marked in tenths and hundredths of a foot on the outside, and sixteenths of an inch on the inside, which costs $1.50. Prices slightly higher on the West Coast. The Eagle Rule Mfg. Corp.

8—FEEDWATER HEATER

For small plants, utilizes exhaust steam to heat water for boiler

Designed specifically for small factories, institutions, public buildings, dairies and laundries with boiler capacities of 300 hp or less, the Junior Feed Water Heater is made of fabricated steel with stainless steel trays which disperse feed water in the form of thin curtains over a large area, so the exhaust



steam gives up its heat quickly and evenly. According to manufacturer, a saving of 1 per cent in fuel will result from each 11 F increase in feed water temperature by use of exhaust steam. Ample water storage space is provided to eliminate need for a sump or well. The Swartwout Co.

9—TUBE AND PIPE FITTINGS

Insert flange, connector and union in corrosion-resistant alloys

Fittings in company's new Speedline series are intended to permit considerable cost reduction in setting up piping systems. Each of the three principal fittings can be used with corrosion-resistant tubing or pipe in Schedules 5S, 10S and 40S.

The insert flange consists of a corrosion-resistant serrated insert in a carbon steel flange. Because relatively little high alloy material is used to provide corrosion resistance, the cost

doing this *costs more* now!

You do it less often

by using Dependable Quality

CRANE VALVES

That's why more Crane Valves are used than any other make

. . . this valve likes tough throttling jobs

—And for durable, maintenance-free service, it's typical Crane quality. The plug-type disc and seat construction in Crane No. 14½P's utilizes the toughest combination of metals found in 150-Pound brass valves. Extra wide seating surfaces give high resistance to damage by "wire drawing" or foreign matter. Crane disc taper is precisely correct for accurate flow regulation.

Whether you need throttling valves or any other type, you'll pay less in the long run by insisting on Crane Quality. Get a demonstration by your Crane Representative.

CRANE

CRANE CO., *General Offices:*
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

of the flange is reduced, company points out, and installation time is also reduced by the elimination of welding, threading and vanstoning.

The new aligning connector can be used to connect heavy-wall Schedule 40S pipe and light-wall Schedule 5S pipe. It is made in sizes for use with corrosion-resistant tubing and pipe from ½ through 4 in. Designed to combine best features of a screwed pipe union and sanitary tube union, this lighter weight union is said to prevent leakage, and it's bi-metallic construction to make it gall free. Horace T. Potts Co.

10—ALIGNMENT INDICATOR

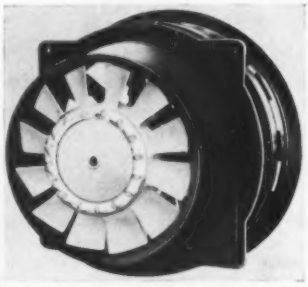
For crankshafts of all types of gasoline, diesel and dual-fuel engines

Use of this sturdy gage during the erection and periodic servicing of an engine is suggested to prevent mechanical breakdown from fractured crankshafts attributable to faulty crankshaft alignment. To facilitate testing operations, the dial can be read in all positions of the crank. This indicator can also be used for checking connecting-rod bearing clearances, cylinder liner wear, deflections of beam. Beekman Industries, Inc.

11—INDUSTRIAL OIL BURNER

In five sizes with Btu ratings from 8 to 34 million per hour

The Coppus-Dennis Fanmix Oil Burner utilizes steam under pressure to atomize oil into minute particles which are discharged through rapidly rotating orifices and thrown outward into a cylindrical "sleeve" of air. This air-fuel mixture is projected into the furnace by a fan rotated by the jet reaction of the steam-atomized oil. The mixing of atomized oil and air brings the oxygen molecules together with the hydrocarbon molecules of the fuel, to provide rapid and complete combustion and a short flame pattern.



Advantages claimed for this new burner are increased boiler ratings, improved fuel efficiency, elimination of hot spots, elimination of need for forced draft equipment, reduced stack requirements, and reduced coking atmosphere. The burner uses any good grade of fuel oil from No. 2 to No. 6 with a viscosity of about 400 SSU. Coppus Engineering Corp.

12—INDUCTION MOTORS

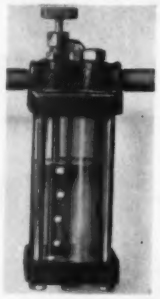
Heavy-duty, wound-rotor type, built in ratings from 30 to 1500 hp

These motors provide variable speed drive and are also suggested for applications requiring high starting torque and low starting current, or long acceleration periods. Drip-proof construction is standard, but splash-proof or enclosed, forced ventilation models are available. The frame is heavy-duty fabricated steel with steel-bar feet. Either ball or split-sleeve type bearings available. Electric Machinery Mfg. Co.

13—SIGHT FEED BUBBLER

And sediment trap, may be mounted on panel or supported in line

Two new units for use in gas and air lines are a sight feed bubbler, to control and indicate relatively small rates of flow, and a sediment trap for removing dirt and moisture. With the bubbler the entire flow of gas or air is passed through liquid in a transparent cylinder, where the rate of flow is shown by bubbles rising through the liquid. A needle valve at the top permits selec-



tion of flow rate. Typical applications include bleeding air into lines to purge them of corrosive fumes, and use with hydrostatic liquid-level gages.

The sediment trap is identical to the bubbler, but without needle valve, dip tube or filler plug. It handles up to 6 cu ft per min at 25 psi differential pressure. There's a drain plug at the bottom of both units for removal of excess liquid. Cylinder is glass or plastic. King Engineering Corp.

14—NICKEL SILVER POINTERS

Are used on heavy-duty pressure and vapor tension temperature gages

Pointers for gages to be used on diesel engines, air compressors and similar units must withstand mechanical vibration, overload and exposure to dust and moisture. To retain accuracy under this kind of abuse, the Rochester Mfg. Co. now produces pressure and vapor tension temperature gages with pointers of 12 per cent nickel silver alloy. Properties of this metal include resistance to corrosion, fatigue and wear, also relatively good electrical conductivity. The Riverside Metal Co.

15—SYNCHRONOUS GENERATOR

High speed, available in four basic designs with 1.875 to 50 kva ratings

Designated Types ATI, ASI and ATB, these newest additions to company's Tri-Clad line have frequency ratings of 60 and 400 cycles. Of the three standard 60 cycle generators the basic one is externally regulated and designed to operate with standard voltage regulator in the exciter field circuit. Standard excitation voltage is 64 v, but equipment for 125 v is available.

A second design provides self-regulated features for applications where average voltage regulation and motor starting ability is desired. The third design involves the basic 60-cycle generator, a special overhung amplidyne exciter and a static voltage regulator, all wrapped in one package. It is applicable where close voltage regulation and excellent motor starting ability is required.

The high frequency 14-pole synchronous generator is suitable for applications which require 400 cycle power, as well as in frequency changer equipments driven by 3500-rpm motors. Small and Medium Motor Divs., General Electric Co.

16—HIGH PRESSURE GASKET

Is engineered to streamline jointed connections, reduce turbulence

The Style CGI Gasket is a compression gage type with both inside and outside ring. It has a spiral-wound construction with alternating V-crimped plies of metal and filler. It is explained that skin friction usually present in pipes sets up little eddies in the fluid passing through it, and at the joint this is increased as the fluid pushes into the recess between flanges. In this new gasket the steel ring is designed to practically fill this recess so no turbulent barrier is set up and the flow is increased.

The gasket is made for most standard ASA and API fittings. Pressure range is 150 to 2500 lb. In addition to stainless steels, the inside ring can be made with nickel, Monel or Inconel. Ring thickness depends on flange face finish and yield factors of the gasket proper. A wide choice of metals and filler materials are available, including Teflon. Flexitallic Gasket Co.

17—ELEVATOR BUCKETS

Are cast integrally with a single link of chain to prevent loosening

The Beaucalloy Uni-Cast Buckets are made of a heat treated alloy steel for durability and the front edge and cor-

ners are reinforced to withstand abrasive action while loading. The bottom of the bucket is flat to prevent arching. Five sizes are available from 8 by 5 in. to 16 by 8 in. Beaumont Birch Co.

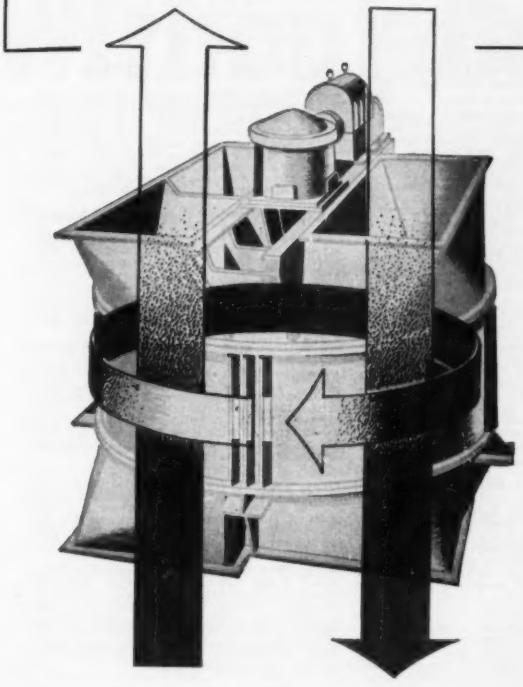
18—MERCURY SAFETY SWITCH

Is hemetically sealed, and mounted on a lever-operated armature

Intended for use in hazardous or explosive locations this switch is available with either push button or selector knob. When knob is turned or button pushed the armature is inclined to actuate the mercury switch. Manufacturer says there is no possibility of a spark because the actuating linkage is purely mechanical. Designed for vertical panel mounting, this is a single-pole switch with either double or single throw action. Panalarm Products, Inc.

Increase the efficiency of your present boiler

with the *Ljungstrom* AIR PREHEATER



The installation of a Ljungstrom air preheater on your present boiler offers the opportunity for considerable fuel savings that will more than offset the initial cost of the preheater in a matter of a few years.

The regenerative counterflow principle of the Ljungstrom permits operation at lower exit gas temperatures . . . assuring increased heat recovery and reducing the amount of fuel required. Moreover, the compactness and lightness of the preheater makes it possible to install it on your present boiler with minimum change in the existing structure.

For more information as to how you can approach modern performance standards with a boiler that is operating without an air preheater, or with out-of-date air preheater, write to the Air Preheater Corporation. Our engineers will welcome the opportunity to show you how the Ljungstrom can raise the over-all efficiency of your plant.

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

THE AIR PREHEATER CORPORATION

60 EAST 42nd ST. • NEW YORK 17, NEW YORK

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

WATER TREATING, CORROSION PREVENTION

201 **Water Conditioning Bulletin**—This is an 8-pp discussion of water and the chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Wright Chemical Corp.

202 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-pp technical bulletin, called Standard Method 123. Discusses pretreatment of raw water, application of chemical feeding to pretreating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater system. Also discusses condensate returns, flushing periods. %Proportioneers, Inc.%

203 **Water Softening Equipment** — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener. The Permutit Co.

204 **Water Treatment** — Bulletin 5000, 24 pp, explains the reasons for boiler water treatment and tells services offered by company in providing formulations to suit individual plant requirements. Covers pre-treatment, internal treatment, treatment application, blowdown adjustment and test control. Filled with photos and layout diagrams, this helpful booklet also describes available equipment and includes a reference bibliography of literature published on specific formulations. Dearborn Chemical Co.

205 **Boiler Corrosion**—A 12-pp article discussing the cause and prevention of corrosion in boiler systems is presented in Betz Technical Paper No. 111 titled "Corrosion: Its Effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. W. H. & L. D. Betz.

206 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in 16-pp Bulletin 28B7030. Describes x-ray diffraction methods for identification purposes. Tables list partial chemical analyses of deposits containing sodium disilicate, occurrence data on compounds found, composition of deposits. Allis-Chalmers Mfg. Co.

207 **Two-Stage Water Conditioner**—Bulletin 4801 describes company's water conditioner which combines the advantages of both hot process and zeolite softening. Explains operation of softener in which the first stage is the hot process using lime or Dolomitic lime and the second stage in which zeolite softener reduces hardness to zero. Cochrane Corp.

208 **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. The Bird-Archer Co.

209 **Chemical Feed Systems** — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It covers various types of feeding, explains automatic control. Milton Roy Co.

210 **Modern pH and Chlorine Control**—This 100-pp booklet gives technical details of company's color comparators and equipment in water testing and control of boiler and industrial process water, also technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining impurities in water; applications of water control in air conditioning; treating boiler feed water. W. A. Taylor & Co.

211 **Water Softeners** — Bulletins WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. Graver Water Conditioning Co.

212 **One-Minute Water Tests** — Rapid, simple and accurate tests for determining water hardness are described in Bulletin 1RE50, 4 pp. Procedures, reagents, and equipment are pictured and described. Bulletin tells how tests may be used to determine water hardness, hardness due to calcium alone and hardness due to magnesium alone. Hall Laboratories, Inc.

213 **Boiler Water Treatment** — Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used. National Aluminate Corp.

214 **Ion Exchange Systems** — "Amberlite Monobed Deionization" is a 12-pp miniature textbook covering the history, behavior, present performance, and potential uses of the Monobed ion exchange systems in water-conditioning, chemical processing and other industries. Reactions of various combinations of exchangers are explained in text and equations. Also discussed are operating costs, equipment costs, quality of product derived, rinse requirements and other properties as they apply to the complete or partial single-step removal of ionized solids. The Resinous Products Div., Rohm & Haas Co.

215 **Pocket Book on Chemicals** — Here's a handy little 28-pp manual covering chemical products used by the power engineer. Most of those listed are water treating chemicals, but there's also a brine treatment, a fuel oil sludge dispersant, a soot remover, and protective coating. Describes each product, tells what it does and how and where to use it. Includes a helpful reference chart suggesting the application of these products to several types of operations. Western Chemical Co.

BOILERS AND AUXILIARIES

216 **Shop-Assembled Boiler** — Eight-pp Bulletin G-72 introduces company's new integral furnace boiler. Describes and illustrates its economy, ease of installation and connection, flexibility, minimum space requirements, efficient combustion, fast steaming and ease of operation. The Babcock and Wilcox Co.

217 **Dowtherm Vaporizer** — Bulletin No. 48-2, describing manufacturer's Type "A" Dowtherm Vaporizer tells how this unit is designed to evaporate Dowtherm in such a way as to provide dependable operation at maximum temperatures, discussing its construction advantages in detail. The Wickes Boiler Co.

218 **The Why of Dual Circulation Generators** — The special advantages of company's dual circulation steam generator are presented clearly and factually in Bulletin B-50-11, 16 pp. Attractively illustrated with installation photos and sketches the text explains the principles of dual circulation. Tells the applications of this type of generator in both high make-up and low make-up plants. Foster Wheeler Corp.

219 **Tube Expanders**—Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economizers, circulating tubes, steam generators other equipment. Thomas C. Wilson, Inc.

220 **Bent Tube Boiler Data**—This 20-pp booklet is filled with engineering drawings of recent installation of company's Class VL boilers, designed for adaptation to limited space conditions in plants having diverse steam requirements. Henry Vogt Machine Co.

221 **Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors, hose. Roto Div., Elliott Co.

222 **Fuel Economizers** — Both cast iron tube economizers and steel tube economizers are covered in detail in Catalog 169, 8 pp. Advantages of their diamond-shaped tubes and streamline flow of gas and soot blower steam are discussed. Green Fuel Economiser Co., Inc.

223 **Water Tube Boilers**—Eight-pp Bulletin SB24B describes and illustrates water cooled boilers with integral water cooled furnace. Explains design features that contribute to positive circulation and low maintenance, as well as construction advantages. Includes dimensions, photos of five installations. Erie City Iron Works.

224 **Air Preheaters** — Illustrated Bulletin A-11610, 8 pp, defines air preheat and explains its benefits in terms of increased efficiency and capacity and flame stability. Provides general description of company's preheater, discusses its application to boiler plants. Several installations are illustrated. The Air Preheater Corp.

VALVES, TRAPS, PIPING

225 **Bonnet Valves**—"Pressure-Seal" bonnet valves are described and illustrated in Form AD-1819. Includes sizes, dimensions, ratings and tests for gate, globe, angle and stop check valves as recommended for high pressure and high temperature service. Also explains operating advantages of the valves and tells how the pressure seal is made. Crane Co.

226 **Valve Bulletin** — Catalog Section 12-H describes various types of company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Edward Valves, Inc.

227 **General Service Valves** — Bulletin E-160, 16 pp, describes and illustrates the design and construction of company's quick-operating valves, explaining their application to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe line. Included are tables of dimensions, weights and list prices. Everlasting Valve Co.

228 **Unions and Fittings** — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. E. M. Dart Mfg. Co.

229 **Blow-Off Valves**—Illustrated Bulletin B-433, 24 pp, describes blow-off valves for high-pressure boilers, and covers seatless, hard-seat and unit-tandem types, for working steam pressures from 400 to 2500 lb. Construction details and operating principles are illustrated by cutaway drawings. Dimensions and specifications included. Yarnall-Waring Co.

230 **Welding Fittings and Flanges**—Catalog and Engineering Data Book 211, a 262-pp manual, provides complete dimensional data, weights and prices on company's welding fittings and flanges. The engineering section contains practical information covering performance under varying conditions of temperature and pressure, location and materials processed. The technical section covers properties and rating of pipe, fittings and flanges, line expansion and flexibility, support and anchorage of piping and flow of fluids. Tube Turns, Inc.

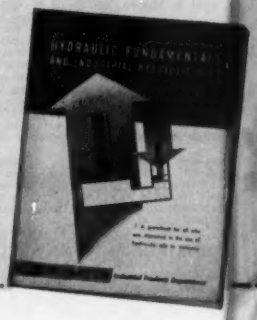
231 **Steam Traps and Temperature Controls**—Here is a comprehensive cata-

NEW SUN PRODUCT CLEANS HYDRAULIC SYSTEMS Without Downtime!

SUN'S NEW HYDRAULIC SYSTEM CLEANER eliminates the production loss and man-hour loss that usually go with the cleaning of equipment. This product does its work *without interrupting production*. It has the detergency to remove the sludges and gums formed by oxidation of hydraulic oil, soaps formed from coolants and cutting oils, and other contaminants. Besides permitting operations to go on undisturbed, it protects the system against further rusting once parts have been cleaned. Sun Hydraulic System Cleaner has been thoroughly "Job Proved" in cleaning up hydraulic systems of presses, machine tools, and circulating systems of a great variety of industrial equipment. It is available in viscosities suitable for any pump. Get peak performance out of *your* equipment by using Sun Hydraulic System Cleaner.

FREE!

to anyone who uses or maintains hydraulic equipment: this booklet by Sun Engineers on the fundamentals of hydraulic systems and the application of hydraulic oils. It will prove valuable as a guidebook in day-to-day work, a refresher course for engineers, or a readable instruction book for nonprofessionals.



Sun Oil Company
Dept. PE-2
Philadelphia 3, Pa.

☐ I should like a copy of "**Hydraulic Fundamentals and Industrial Hydraulic Oils.**"

☐ I want more information about **Sun Hydraulic System Cleaner.**

Name_____

Title_____

Company_____

Street_____

City_____ Zone_____ State_____

SUN INDUSTRIAL PRODUCTS

SUN OIL COMPANY, PHILADELPHIA 3, PA. • SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

SUNOCO

log comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap selection chart. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Contains sizes, application data, prices. Sarco Co., Inc.

232 **Steam, Air, Gasoline Traps** — This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 225 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb, and also steam, air and gas separators. Includes capacity tables, installation diagrams. W. H. Nicholson & Co.

233 **Handbook on Fittings and Flanges** Catalog wf-1950, 88 pp, is packed with working information on seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings in other metals. Grinnell Co., Inc.

234 **How to Choose and Use Air Traps** —Bulletin 202, 4 pp, describes manufacturer's complete line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, and drip points. Prices included. Armstrong Machine Works.

235 **Safety Valve Engineering Data**—How company's safety valve works and its important operating advantages are explained and illustrated in Bulletin 707. Includes dimensions on flanged and welded inlet valve types, tables on superheat correction factor, capacities in pounds of saturated steam per hour. Manning, Maxwell & Moore, Inc.

236 **Flanges for Severe Service** — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Also covers a flexible rubber pipe for use with abrasive or corrosive material, and an acid- and corrosion-resistant duct. Goodall Rubber Co.

237 **To Make Valves Accessible** — This little folder describes a sprocket rim with chain guide. The rim adjusts to fit all valve wheels and makes them readily accessible. Prices given. Babbitt Steam Specialty Co.

INSTRUMENTS AND CONTROLS

238 **Instrument and Control Panels** — Bulletin 773, 8 pp, explains how company's panels are made and where they are used. All operations of fabrication are discussed and illustrated—layout, cutting, drilling, welding, fitting, painting, wiring. The Hays Corp.

239 **Remote Reading Flow Meters**—Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described. Republic Flow Meters Co.

240 **What's Going On Inside?**—Sight flow indicators for insertion into pipe lines carrying oil, steam, water, cooling liquids are described in Bulletin DD, 4 pp. Covers both cylinder and window types. Ernst Water Column & Gage Co.

241 **Flow Meters**—Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1½ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, the bulletin explains how meter operates, discusses its advantages. Builders-Providence, Inc.

242 **Putting the Ratio Totalizer to Work**—Twelve suggested applications of company's ratio totalizer in automatic control circuits are described and illustrated by diagram in 8-pp Bulletin 5450. This new device is a pneumatically operated control mechanism for combining input control pressures and spring forces to produce a single output control pressure. Applications in computing circuits include addition, subtraction, multiplication and division, averaging and reversal of loading pressure. Hagan Corp.

243 **For Practical Men**—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. James G. Biddle Co.

244 **Air Locks**—Bulletin S-31, 2 pp, describing company's air locks and trip master controls for holding regulating and control valves in position during failure of air supply, is illustrated with photos, diagrams and line drawings. The Swartwout Co.

245 **Flow Tube** — Catalog 80, 4 pp, presents engineering data on a new primary element for measuring, regulating and controlling fluid flow. Tells how these flow tubes are designed and how they function and discusses their advantages. Foster Engineering Co.

246 **Control Equipment**—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pilot equipment. Simplex Valve and Meter Co.

247 **Pressure Regulator**—Bulletin 1-B, 8 pp, discusses design, operation and applications of a super-sensitive pressure regulator; shows typical installations. Also covers a compound regulator for controlling back pressure relief valve and high pressure make-up valve. Atlas Valve Co.

248 **Control Linkage**—General Specification CA942, 16 pp, presents control linkage for company's control drive and also contains engineering price data. Explains and illustrates flexible control design drive levers, driven levers, connecting links, bearings and shaft and cable, also rotation over 90 deg. Bailey Meter Co.

249 **Pressure Reducing Valves**—Selection and engineering data on pressure reducing valves, including those for remote control of reduced steam or water pressures, are presented in 12-pp Bulletin 477-A. Valve types are illustrated. Also described and illustrated is company's desuperheater. Northern Equipment Co.

250 **Index to Information** — Compiled to help power engineers obtain literature wanted on chemical proportioning equipment, volumetric and gravimetric feeders, and recording, indicating and control instruments, 4-pp Bulletin BIF-1 describes briefly 36 available bulletins covering this equipment. BIF Industries.

PUMPS, COMPRESSORS, ENGINES

251 **For Many Pumping Jobs**—The Series A313A, latest of company's well-known IMO pumps and especially designed for low cost standardized, quantity production, is described in illustrated Bulletin L313A-B, 8 pp. This is a general service screw-type rotary pump for petroleum products and other light or viscous fluids as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. De Laval Steam Turbine Co.

252 **Compressor Selection Chart**—Here's a selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Worthington Pump and Machinery Corp.

253 **Air Compressor Lubrication Manual** —Valuable information on air compressor maintenance is contained in this 40-pp illustrated book. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements, operating hints, oil requirements, storage and care of compressor oils, and safety precautions. Cities Service Oil Co.

254 **Modern Steam Engines**—In presenting steam engines as more than "just drives," Bulletin 306 touches briefly upon some of the advantages of "by-product" power. Bulletin features company's vertical steam engines of both throttling and automatic governor types. Troy Engine & Machine Co.

255 **Boiler Feed Pumps**—Bulletin 109, 16 pp, illustrated in color, describes in detail centrifugal pumps for boiler feed service. Explains and pictures construction and major parts, explaining in detail the floating seal incorporated. Capacity data is provided, also vapor pressure tables. Pacific Pumps, Inc.

256 **Pulsation-Free Compressor Piping**—Illustrated Bulletin PDS-8501, 4 pp, describes company's pulsation dampening piping system. Tells how this piping compares in first cost to other piping, but affords higher operating efficiency, improved flow measurement and lower maintenance costs. Explains pulsation phenomena in gas compression systems and how dampening principle is applied. The Fluor Corp., Ltd.

257 **Centrifugal, Reciprocating Pumps**—This is a helpful collection of bulletins covering many types of centrifugal and reciprocating pumps for a wide range of services. Includes data on single-stage and multi-stage pumps, close-coupled pumps, high pressure pumps, pumps especially suited for handling erosive and corrosive liquids and others. Warren Steam Pump Co., Inc.

ELECTRICAL

258 **Power Factor Correction**—Examples illustrating basic considerations in the improvement of system power factor are contained in Bulletin 05B7465, 4 pp. It points out economical and operational advantages of improving plant power factor and advisability of keeping the load power factor up to 0.8 lagging or higher, and tells how the effects of low power factor can be corrected. Allis-Chalmers Mfg. Co.

259 **Synchronous Motors** — High speed synchronous motors are described in 4-pp bulletin PB 5600-1. The bulletin is packed with descriptive matter and photographs explaining features. Elliott Co.

260 **Low-Speed Synchronous Motors** — Publication GEA-5332, 8 pp, illustrates typical installations of efficient high-power factor, constant-speed drives, describes their construction features, and indicates mechanical modifications and performance data. General Electric Co.

261 **Care of A-C Rotating Equipment**—To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin 05B7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and such subjects as drying moist insulation, measuring insulation resistance. Allis-Chalmers Mfg. Co.

COAL HANDLING

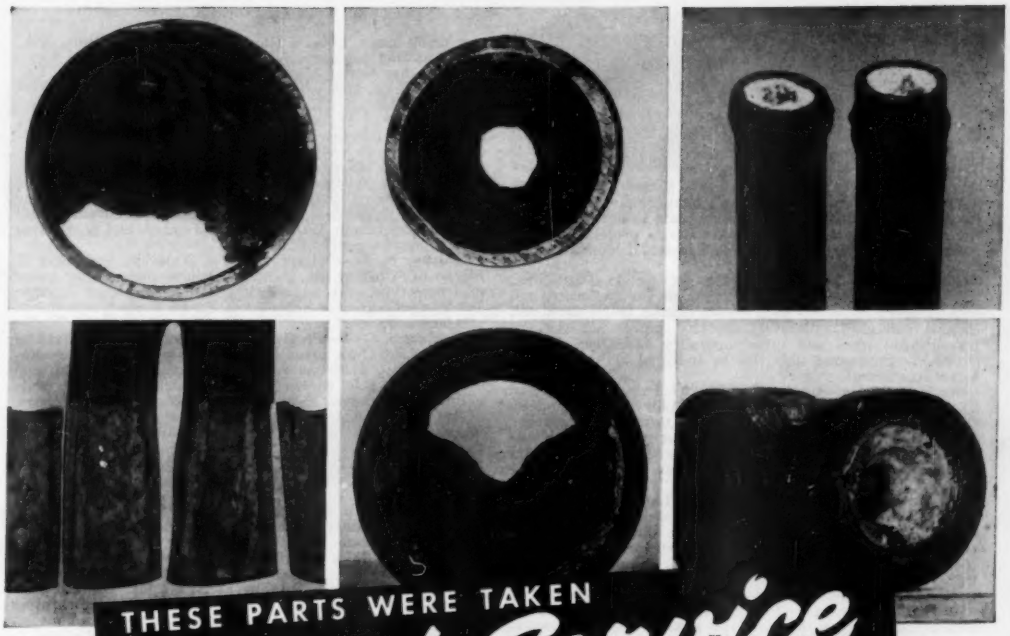
262 **Spreader Stoker** — Bulletin 890, 40 pp, describes a spreader stoker with overthrow rotor designed to provide uniform fuel distribution. Discusses advantages of this type of stoker, including its efficiency in the burning of many grades of coal and in handling of fluctuating loads. Power-operated and hand-operated dumping grates and stationary grates are described and illustrated. Book includes photos of installations. Detroit Stoker Co.

263 **Coal Handling Equipment**—Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 300. Illustrated, covers concrete and tile silos, cylindrical steel tanks, suspended steel bunkers. Gifford-Wood Co.

264 **Spreader Stoker Selection** — Fourteen-pp Form P-520-A10M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered. American Engineering Co.

265 **Spreader Stoker Data**—This is a file of three illustrated bulletins on spreader stokers. The first discusses seven reasons for selecting these stokers and describes their design, construction and operation; the second, dumping grates, the third, installations. Riley Stoker Corp.

(Continued on page 146)



THESE PARTS WERE TAKEN

Out of Service

BECAUSE OF SCALE

DEARBORN FORMULA 134 ELIMINATES SCALE

● These destroyed parts represent a large, unnecessary investment in equipment, labor and shut-down time. Conditions like these can easily and economically be avoided with Dearborn Formula 134. Wherever water travels—scale tends to form. Formula 134 is a concentrated solvent for the rapid removal of scale in heat exchange units, boilers, pumps, feed lines, meters, condensers and other valuable equipment.

Formula 134 is just one of many Dearborn formulas used to save equipment, reduce shut-down time and maintenance costs. Other Dearborn formulas control acidity of condensate, prevent excessive foaming and prevent corrosion of metal in contact with calcium and sodium chloride refrigerating brines. For the correct water treatment to best meet your needs—consult Dearborn.

DEARBORN CHEMICAL COMPANY
310 S. Michigan Ave. • Chicago 4, Ill.

SAFE, SIMPLE APPLICATION

with specially designed, inexpensive pump also supplied by Dearborn! Send for Bulletin 5002 which describes in detail methods for the removal of scale with Dearborn Formula 134.

DEARBORN CHEMICAL COMPANY
310 S. Michigan Ave., Dept. PG
Chicago 4, Illinois
Gentlemen:
Please send me information on Dearborn Formula 134.

Name.....

Company.....

Address.....

City.....State.....

Dearborn
TRADE MARK REGISTERED
THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

WATER TREATMENT AND SOFTENING COMPOUNDS • COMPLETE ENGINEERING SERVICE • NO-OX-ID RUST PREVENTIVES

POWER PLANT Construction News

Fresno, Calif.—Board of Fresno County Supervisors, Court House, Fresno, plans central-heating plant in new multi-unit tuberculosis hospital on local site. Entire project will cost about $2,750,000. David D. Horn and Marshall Mortland, 1244 O St., Fresno, are architects.

Denver, Colo.—Public Service Co. of Colorado, 900 15th St., has authorized fund of about $24,000,000 for expansion and improvements in plants and system during 1951. Work will include increased generating capacity, power sub-stations, transmission lines and other operating facilities. A new 60,000-kw generating unit will be installed at location still to be determined.

Hartford, Conn.—Connecticut Light & Power Co., 36 Pearl St., Hartford, has engaged Charles T. Main & Co., 80 Federal St., Boston, Mass., consulting engineer, to make surveys and estimates of cost of a proposed hydroelectric generating station on Housatonic River, near Lake Zoar. Preliminary estimates indicate that project will cost in excess of $10,000,000.

Wilmington, Del.—Delaware Power & Light Co., 600 Market St., is arranging an appropriation of about $15,000,000 for expansion and improvements in plants and system during 1951. Work will include proposed extensions in new Edge Moor steam-electric generating station, Wilmington, where initial unit is now in course of completion; transmission lines, power substations and other operating facilities.

Indiana Harbor, Ind.—Youngstown Sheet & Tube Co. plans extensions in power plant at local steel mill, in conjunction with an expansion program for large increased output of pig iron, steel and coke. Installation will include a new high-pressure turbine-generator and auxiliary equipment; also enlargement of water-treating plant, new pumping station and other work; new slab heating furnaces, turbo-blower and miscellaneous accessory equipment. Entire project is reported to cost $90,000,000, and will require a number of months for completion. Main offices are at Youngstown, Ohio.

Louisville, Ky.—Philip Morris & Co., Ltd., 100 Park Ave., New York, N. Y., cigarettes and tobacco, plans central-heating plant in new seven-story storage and distributing plant, 110 x 150 ft, at Louisville, for which general erection contract will be awarded soon. Cost estimated about $3,000,000. Lockwood, Greene Engineers, Inc., 10 Rockefeller Plaza, New York, is architect and engineer.

Paducah, Ky.—U. S. Atomic Energy Commission, 1901 Constitution Ave., N.W., Washington, D.C., plans steam-generating plant at new uranium production facility on site of Kentucky Ordnance works, near Paducah. Smith, Hinchman & Grylls, Inc., Marquette Bldg., Detroit, Mich., is architect and engineer. Entire project will comprise a large group of buildings, power substation, and other utilities, and will represent an investment of about $350,000,000.

Baton Rouge, La.—Ideal Cement Co., Denver National Bldg., Denver, Colo., plans boiler plant at proposed new mill at Baton Rouge. It will comprise a number of one and multi-story units, equipped for a capacity of 1,500,000 bbl per annum. Cost reported close to $2,500,000.

Baltimore, Md.—Consolidated Gas, Electric Light & Power Co., Lexington Bldg., is arranging for sale of a bond issue of $25,000,000, majority of proceeds to be used for expansion and improvements in plants and system, including generating plants, power substations, transmission and distributing lines.

Frederick, Md.—Lansdale Tube Co., Inc., Lansdale, Pa., television and electronic tubes, plans boiler plant at new factory on 50-acre tract of land at Frederick. It will consist of several one-story buildings, and is reported to cost approximately $1,000,000. M. Ward Easby, Inc., 1201 Chestnut St., Philadelphia, Pa., is consulting engineer. Company is a subsidiary of Philco Corp., Tioga and C Sts., Philadelphia.

Boston, Mass.—New England Provision Co., Inc., 27 Fulton St., sausage and other prepared meat products, plans boiler house at new meat-processing plant, on Southampton St., Roxbury District, for which work will begin early in spring. Entire project is reported to cost over $800,000. Henschen, Everds & Crombie, 59 E. Van Buren St., Chicago, Ill., are consulting engineers.

Crystal Falls, Mich.—Wisconsin-Michigan Power Co., 137 W. Mill St., Appleton, Wis., has authorized plans for new hydroelectric generating station on Michigamme River, near Crystal Falls. Details of capacity and estimates of cost are new being made. Mead & Hunt, 550 State St., Madison, Wis., are consulting engineers.

Greenville, Miss.—Alexander Smith & Sons Carpet Co., Yonkers, N. Y., rugs and carpets, plans boiler plant at proposed new branch mill at Greenville. It will be one-story, about 600,000 sq ft floor space, and is reported to cost close to $7,000,000, with machinery and facilities. Erection is scheduled to begin at early date.

Springfield, Mo.—Lily-Tulip Cup Corp., 122 E. 42nd St., New York, N. Y., paper cups, dishes, etc., plans boiler house at proposed new branch converting plant on North Glenstone Ave., Springfield, where site has been secured. It will be one-story, about 450,000 sq ft floor space, and is reported to cost approximately $2,000,000.

Crosby, N. D.—Sodium Corp. of America, Inc., 8124 S. Hoyne St., Chicago, Ill., sodium sulphate, plans boiler house in connection with new dehydration plant, near Crosby. Work is scheduled to begin soon. Entire project reported to cost about $350,000.

Cincinnati, Ohio—Progressive Lithographing Co., Reading Rd., Reading, Ohio, plans central-heating plant in new one-story factory, 70,000 sq ft floor space, at Section Rd. and Pennsylvania R.R., Amberly Village, Cincinnati. Entire project estimated to cost about $2,000,000. Work will begin soon.

Anadarko, Okla.—Western Electric Cooperative, Inc., Woodward, Okla., is having plans prepared by Laramore & Douglass, 79 E. Adams St., Chicago, Ill., for proposed new steam-electric generating plant at Anadarko. Cost reported about $800,000. Financing has been arranged through Federal Aid.

Butler, Pa.—Air Reduction Sales Co., 60 E. 42nd St., New York, N. Y., industrial oxygen, acetylene gas, welding apparatus, etc., plans boiler house at new plant at Butler, to be one-story, 75 x 380 ft. Entire project reported to cost about $500,000.

Aiken, S. C.—South Carolina Electric & Gas Co., 328 Main St., Columbia, S. C., plans new steam-electric generating station on site in vicinity of Aiken, to be equipped for an ultimate capacity of 300,000-kw. Initial unit is estimated to cost about $12,000,000, with power substations, transmission lines and other operating facilities.

Honea Path, S. C.—Westover Mills, Inc., West Warwick, R. I. (formerly Westover Fabrics, Inc.), plans boiler plant at new rayon weaving mill at Honea Path, where site has been acquired. Mill will be one-story, about 90,000 sq ft floor space. Entire project will cost about $1,000,000. Work will be placed under way soon.

New Johnsonville, Tenn.—Tennessee Valley Authority, New Sprankle Bldg., Knoxville, Tenn., plans expansion in steam-generating station now in course of construction at New Johnsonville, including installation of two new generating units and auxiliary equipment. Federal appropriation approved. Entire project will represent an investment of about $30,000,000.

Dallas, Tex.—Ford Motor Co., Dearborn, Mich., plans boiler plant at proposed new parts and service building on Industrial Blvd., near Continental Ave., Dallas. It will be one-story, about 250 x 500 ft. Cost reported over $1,000,000. Austin Co., 16112 Euclid Ave., Cleveland, Ohio, is engineer, and will be in charge of erection.

Earth, Tex.—Southwestern Public Service Co., Amarillo, Tex., has plans maturing for new steam-electric generating plant at Earth, where large tract of land has been selected. Cost reported about $6,000,000, with turbine-generator, high-pressure boiler and accessory equipment. Proposed to begin work soon.

Richmond, Va.—Ford Motor Co., Dearborn, Mich., plans boiler house at new one-story automobile parts building at Byrd Airport, near Richmond. It will approximate 130,000 sq ft floor space, and will be used for storage, distribution, and general service. Cost reported close to $1,000,000. Work is scheduled to begin soon.

Wheeling, W. Va.—Wheeling Steel Corp. plans extensions in power plant at steel mill, with installation of equipment for increased capacity. Work will be carried out in conjunction with expansion program at mill for larger steel output. Entire project is reported to cost about $8,750,000.

Green Bay, Wis.—Wisconsin-Michigan Power Co., 137 W. Mill St., Appleton, Wis., is reported considering new steam-electric generating station on Fox River, near Green Bay. Plant will be equipped with turbine-generators, high-pressure boilers, and auxiliary equipment for large capacity. Time of work yet to be determined. Cost estimated about $20,000,000, with power substations, transmission lines and other operating facilities.

Green Bay, Wis.—Wisconsin Public Service Corp., Bellin Bldg., has plans maturing for superstructure for proposed new addition to local Bayside steam-electric station. It will be equipped for increased capacity in steam and electrical departments. Entire project to cost about $8,000,000.

more than 3800 COPES Multi-Element Regulators in more than 1300 plants

LOOK at the record. More than 1300 plants depend on COPES Multi-Element Regulators for accurate feed-flow and water-level control on their fast-steaming high-duty boilers. Some use the COPES Balanced Flow, actuated by steam flow, feed flow and water level. Others use COPES Flowmatic, the most widely used two element regulator. Let this wide experience help you operate your boilers more safely, more efficiently. May we show you how?

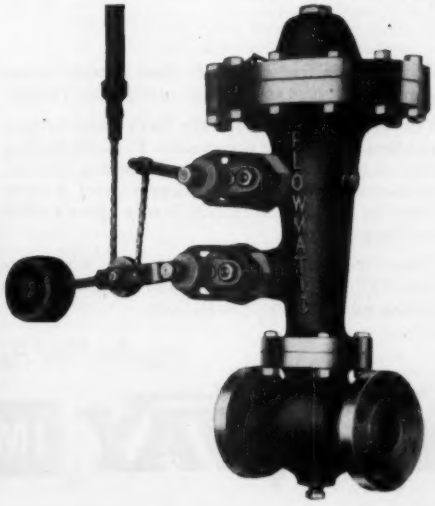
NORTHERN EQUIPMENT DIVISION
Continental Foundry & Machine Company

212 GROVE DRIVE **ERIE, PENNSYLVANIA**

COPES

Headquarters for . . .

Boiler Feed Water Control . . . Excess or Constant Pressure Control, Steam or Water . . . Liquid Level Control . . . Balanced Valves . . . Desuperheaters . . . Boiler Steam Temperature Control . . . Hi-Low Water Alarms.



What if it is freezing cold—your exposed steam traps won't cause you any worry if they're Yarway.

Yarway Impulse Steam Traps don't freeze because condensate does not accumulate. The only moving part—a little valve—is continually testing for condensate and passing it as soon as it forms. It never waits for a trapful to collect. Hence, there's never anything to freeze.

There are other good reasons, too, why more than 650,000 Yarways have been bought for both indoor and outdoor installations.

They get equipment *hotter, sooner.* They are *small in size, light in weight, easy to install and maintain.* They are *good for all pressures.* Construction is *stainless steel.*

Prove these advantages in your own plant at our expense. Try a Yarway *for free.* Call your nearby Yarway distributor or write direct to . . .

YARNALL-WARING COMPANY
114 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

Stainless Steel Body

YARWAY IMPULSE STEAM TRAP

LETTERS TO THE EDITORS

RED FACE DEPARTMENT

As YOU editors know, the power engineeers who read POWER ENGINEERING are a bunch of gimlet-eyed fiends for detail. I am one of those gimlet eyes myself and I want to compliment you on your January 1951 issue because it presented a perfectly astounding mass of technical information about the power industry, in which I noted only three minor typographical errors. Most issues I never find any. The three are:

a. Page 59-Fig 3. Red shaded portion of cut obviously upside down.

b. Page 60-Col 2-Par. 3-last sentence:—The number 1500 F obviously was meant to be 1050 F, otherwise text following it would not read logically.

c. Page 70-Col 1-Par. 1-Line 10:—15,000-kw unit should obviously read 150,000-kw unit, since it is clear from the rest of the paragraph and from the subtitle that is what you meant.

I find so few errors in POWER ENGINEERING that when I do spot one it sticks out like the well-known sore thumb. I know your objective is 100 per cent efficiency. But who am I to throw rocks? If my power plant operations came as close to 100 per cent efficiency as your editorial operations do . . .

Chicago, Ill. AMBITIOUS AL

Editor's Note:—Nevertheless, Al, our faces are redder than Joe Stalin's national emblem. Yes, we discovered those errors with horror after the last copy was off the press and it was too late to make corrections. "Ve poot it in so-o-o svee-e-e-et—und it gome oudt so-o-o SOUR-R-R-R!"

DISTILLATION OF SEA-WATER

I HAVE to thank the U.S.A. Library at Tel-Aviv which has supplied me with two copies of POWER ENGINEERING which include articles on the subject of converting sea-water into potable water by distillation.

This problem is of acute importance to the southern part of Israel (Negev), which is rich in salty water and very poor in petroleum resources. It has, therefore, occurred to me to ask myself, whether it might be possible to evaporate the salt water at a low temperature, without necessarily using the compression method, which has proved to be the most effective method up to date. This method has shown that we can distill 200 kg of water with 1 kg of fuel, therefore the necessary calorific heat is comparatively small, namely 50 kg cal per kg of water distilled. Then, may I ask, why not use directly the vacuum evaporation method, by evaporating hot water under reduced pressure and cool the vapors by the same salt water? The salt water can easily be heated in desert-like countries by means of solar radiation and brought up to temperatures of 70 to 80 C. It seems to me that at these temperatures, and even lower ones, we can obtain a continuous cycle of evaporation and condensation that should, in my opinion, be much cheaper than the method of compression.

My idea is based principally on the fact that the precipitation of dew or rain is also a result of solar evaporation of the sea-water and then condensed by the cooling effect of the wind and lower temperature in the upper regions of the atmosphere. Therefore, according to the law of conservation of energy, the distillation of sea-water by Nature costs nothing, owing to the balance of temperatures caused by solar heat on the earth. By harnessing solar heat for heating the water, there will remain to us only the task of providing motive power for the operation of the vacuum pump. But I am under the impression that the heat contained in the condensed distillate is more than sufficient to pay, in the way of providing hot water for various domestic purposes, the equivalent of fuel required to operate a Diesel engine.

I would like very much to have opinions of other readers of POWER ENGINEERING on this subject. If my idea is sound scientifically, perhaps it can be worked out commercially for the general benefit of mankind.

41 Rothschild St. I. MARSHAK
Petah-Tiqva, Israel

See Compression Distillation, *Power Plant Engineering*, February, 1946. There was also later comment in a letter, about the interest on the West Coast in various methods of evaporating and distilling large quantities of sea water, as a possible hedge against future water shortages.—Editor.

HARNESSING THE SUN

THE ARTICLES on the possibility of building a thermoelectric generator by Curtiss Basset in recent issues bring to mind other methods of producing power, particularly, the direct conversion of the light and heat of the sun's rays into power.

Most everybody who has given attention to this subject must be familiar with the work of Dr. Greely Abbot of the Smithsonian Institute in this field. Dr. Abbot spent some 20 years developing an effective engine run by the sun's rays. By means of glass tubes arranged coaxially so that the inner tube is jacketed by two outer tubes, the entire arrangement mounted in front of reflecting mirrors, he was able to obtain temperatures of as high as 932 F, and steam in sufficient amounts to run a small steam engine.

Another solar researcher, Otto Mohr, built himself a solar home in which the sun does a good share of the domestic work. By properly focusing the sun's rays he maintains a constant supply of hot water, ranging as high as 190 F, if desired. In contrast to this, a focussed spot of sunlight replaces the gas flame in his refrigerator.[1]

A most interesting use to which the sun has been put is to give light, paradoxical as that might sound. This thought occurred to Pierre Arthuys, a French engineer who lived in a gloomy flat in Paris, facing north. He began to experiment, and the result was an apparatus which actually put the sunlight on tap for domestic purposes, provided, of course, that the sun was visible.

This ingenious Frenchman calls his apparatus the Arthel Heliostat. Basically, it consists of one movable and one fixed mirror and two or more electric motors controlled by thermostats. The machine is mounted on the roof. The large movable mirror, mounted on a pivot, is slowly moved by an electric motor through the arc of a circle, thus following the sun in its path across the sky.

The second motor, also connected to the mirror, is a self-starter. It is controlled by the sun itself, through the action of two sensitive thermostats. When the sun rises, the mirror is facing west where it stopped the night before. Thermostat No. 1 and the starter motor then promptly go into action. The warmth of the first rays of the morning sun, no matter how weak, through the thermostat, starts the motor and the mirror quickly swings over to the east. From that point on, the mirror is turned by the other sun-controlled motor. If the sun is obscured by a passing cloud, the thermostat immediately stops the motor, at the same time switching on the electric lights in the rooms below. When the sun emerges again, the starter motor goes into action once more, swinging the mirror forward until it catches up with the advanced position of the sun.

This system of illumination is combined with a light distributing system in the building or buildings below. Above the movable mirror there is a large fixed mirror facing

(Continued on page 90)

[1] It would be interesting to know how Dr. Mohr's refrigerator keeps running at night. Editor

Power Engineering's FEATURE OF THE MONTH

A Study of Coal Analyses From the Standpoint of the User

How accurately do you know the characteristics of the coal you are burning? Are you getting what you are paying for? Does the coal you actually burn meet the specifications you lay down? How well can you rely on your laboratory's analysis? What is your sampling procedure and how good is it? If you know the answers to all these questions perhaps you do not have to read this article but if you don't, you will find Mr. Reiter's consideration of the subject of great interest and value. Even if you do not buy as many thousands of tons of coal a year as the Dayton Power & Light Co., you will still be able to benefit from Mr. Reiter's discussion of his company's methods in the purchase and analysis of its coal

By **FRED M. REITER**
Materials Research Engineer, The Dayton Power & Light Company, Dayton, Ohio

A SHEET of paper commonly known as a laboratory report generally supplies the background for a "Study of Coal Analyses." This laboratory report stems from a series of operations that are so important that the reports may be worthless if these fundamental operations are not properly performed. These operations include sampling of the coal, preparing and delivering the final resultant pounds of sample to the laboratory, the chemical determinations in the laboratory, and finally the interpretation of the results.

If any of these steps are faulty, all subsequent work is not only a waste of time and effort, but the coal or the laboratory may be erroneously judged. This often results in loss of coal sales, loss of coal supply to the consumer, with corresponding effects on the mine and other agencies involved.

A. Taking the Sample

How was the sample taken? The builders of older boiler plants did not apparently deem that question worth the cost of an adequate answer. But new plants have gone all the way to get representative samples of the coal.

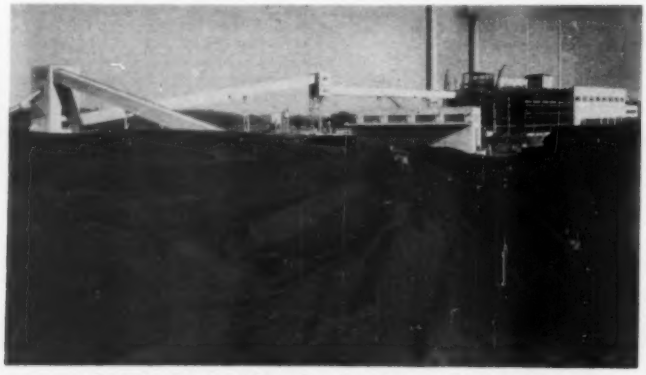


Fig. 1. General view of the coal handling plant at Hutchings Station

The Dayton Power and Light Co. has four large steam and power stations of various ages and types of coal handling equipment. They therefore have four distinct methods of sampling coal: from hand sampling on the cars to a fine automatic belt gathering, crushing and sampling machine that does the whole job in one operation. In this last plant no hands touch the coal in the process up to the final 100 lb which are riffled or quartered to the final jars of the laboratory sample.

Figure 2 shows a flow diagram of the automatic sampler. Table I summarizes the four methods of sampling used at these four plants. The range in method of taking the samples from the cars, the number and size of increments, weights of gross sample, means of crushing to sampling sizes, and the method of quartering down to the final laboratory jars, varies widely. We can therefore compare the results derived from various types of sampling directly within our own Company, without reference to data from other sources. Such a situation might be advantageous for research studies but from a practical standpoint I should not speak loudly of our diversity.

Tables II, III and IV show the results of analyses of three coals used by at least three plants with their different methods of sampling.

All three coals were used in Plants 1 and 2 concurrently with one

of the newer plants at the time of selection for this comparison. Samples of coal "C" were obtained at all four plants. The dates of the sampling for this study are given for each coal and plant. The number of samples taken are also given. Coal "C" did not have as many samples as might be desired. More samples would have accentuated the divergence in results between Plants 1 and 2. All sampling was done by our own personnel as shown in Fig. 1. Most of the analyses were run by a commercial laboratory.

The tabulation is intended to show the divergence of results from the four methods of sampling. The fact that the averages come out so close almost rules out many variables that one might introduce; such as weather, variations in the coal in its various cars to the different plants, sampling discrepancies, etc. In other words, the taking of many samples of a given coal has the cumulative effect of increasing the number of increments and gross size of the over-all sample, so that the average of many samples tends to become a pretty accurate figure, regardless of the method of sampling.

This study shows that:

1. The over-all averages of many analyses for each source of coal do not vary much among the four plants. Regardless of the method of sampling if enough samples are taken, the over-all average will become a fairly representative value comparable with good sampling practice at other plants.

2. Individual samples improperly taken cannot be depended upon to give acceptable analyses.

3. ASTM standards should be taken at least as the very minimum requirements in sampling coal. Studies now under way may prove even these to be inadequate in correlating analyses of samples of a car of coal taken at different and distant points. In order to help judge the validity of any coal analyses the laboratory sheet should record the size and number of increments and the weight of the gross sample taken.

4. The continuity of the ash-moisture free Btu values can be utilized for any given coal for which a value has been recently accredited, can serve as a guide to possible errors in laboratory determinations.

There is nothing new in these findings. The coal industry, both producers and users, have been discussing these conclusions for decades. The wonder is that improper methods of sampling exist even though there may be doubts as to the reliability of the results.

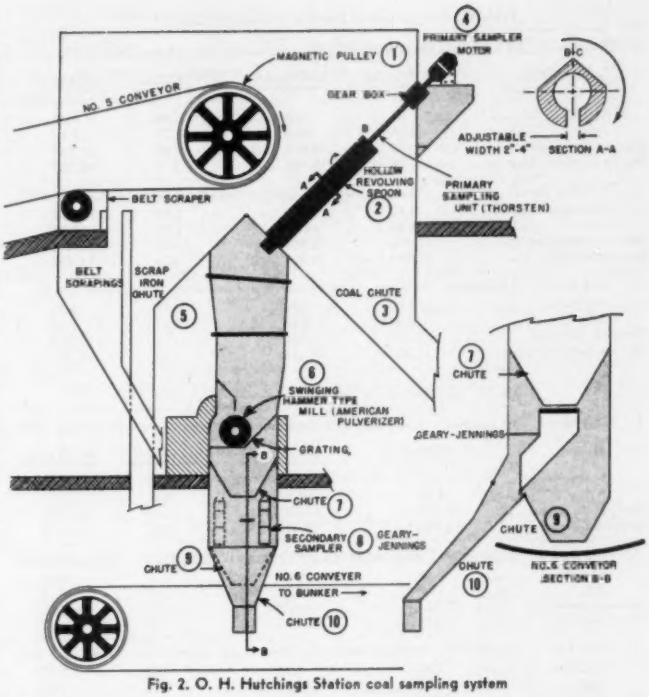


Fig. 2. O. H. Hutchings Station coal sampling system

Looking at these laboratory reports, where would you place the blame for the poor showing of cars 1 and 3? Would you reject cars 1 and 3? Would you send the samples to a referee laboratory?

B. The Sample Goes to the Laboratory

Let us now go over to the chemical laboratory and look at the reports of their analyses. The chemist gets blamed quite often for the poor quality of a coal.

The chemist has no pesonal interest in the product he analyzes and tries impartially to do his best job within the limits of his capacity in following the methods prescribed by ASTM. He receives the samples from the plant or mine in a container and proceeds from that point in his laboratory routine. Many firms send samples in sealed quart jars, filled immediately after quartering

Table I. Comparison of Sampling Methods of Four Boiler Plants

Item	No. 1 Steam Plant	No. 2 Steam Plant	No. 3 Power Plant	No. 4 Power Plant
1. Method of firing	Underfeed stoker	Underfeed stoker	Pulverized coal	Pulverized coal
2. Coal cars unloaded by	Overhead bucket	Bottom to skip	Bottom to skip	Car dumper
3. Coal carried by	Crane bucket	Skip hoist	Skip to conveyor	Conveyor throughout
4. Coal sampled	In car	Under hopper	From conveyor	From conveyor
5. Sampled by means of	Hand scoop	Hand shovel	Hand shovel	Automatic scoop
6. Sample crushed by	Hand tamping	Hand tamping	Machine	Automatic machine
7. No. of increments per car	13	5	60	45 @ 25 lb.
8. Lbs. gross sample per car	80	40	500	1200
9. Type of man taking sample	Laborer	Operator	Technician	Technician
ASTM Minimum Sampling Requirements (D492)				
10. Increments (6 lb each)	20	20	15	20
11. Gross sample, lb	120	120	90	120

Table II. Comparison of Samples of Dorothy Coal "A"

	MINIMUM	MAXIMUM	DIFFERENCE	AVERAGE (All 23 samples)
1. Plant No. 1. 23 samples. Analyses made by commercial laboratory. Sept. 1949				
Moisture	1.81	11.40	9.59	4.09
Ash	6.36	9.13	2.77	7.10
Btu—as received	12,468	14,013 (+)	1545	13,554
Btu—ash-moist. free	15,084	15,405 (+)	321	15,257
2. Plant No. 2. 17 samples. Analyses made by commercial laboratory. Sept./Nov. 1948.				
Moisture	1.82	11.43	9.61	7.17
Ash	5.85	14.66	8.81	8.03
Btu—as received	12,292	13,705	1,413	12,935
Btu—ash-moist. free	14,994 (—)	15,520 (+)	526	15,267
3. Plant No. 4. 4 Samples. Analyses made by our own laboratory. May/July 1949.				
Moisture	5.00	5.88	0.88	5.41
Ash	6.89	8.40	1.51	7.37
Btu—as received	13,174	13,446	272	13,303
Btu—ash-moist. free	15,231	15,372	142	15,301

Table III. Comparison of Samples of No. 5 Block Coal "B"

	MINIMUM	MAXIMUM	DIFFERENCE	AVERAGE
1. Plant No. 1. 10 samples. Analyses made by commercial laboratory. July/Aug. 1948.				
Moisture	1.87	8.07	6.20	4.17
Ash	5.56	14.02	8.46	10.97
Btu—as received	12,125	13,658	1,533	12,900
Btu—ash-moist. free	14,942 (—)	15,485 (+)	543	15,199
2. Plant No. 2. 12 samples. Analyses made by commercial laboratory. May/June 1947.				
Moisture	2.66	9.03	6.37	4.46
Ash	6.47	12.34	5.87	9.16
Btu—as received	12,569	13,628	1,059	13,033
Btu—ash-moist. free	15,148	15,303	155	15,232
3. Plant No. 3. 5 samples. Analyses made by commercial laboratory. 1948.				
Moisture	2.38	4.23	1.85	3.60
Ash	8.08	10.54	2.46	9.40
Btu—as received	13,029	13,235	296	13,154
Btu—ash-moist. free	14,839 (—)	15,379 (+)	540	15,122

Table IV. Comparison of Samples of Dorothy Coal "C"

	MINIMUM	MAXIMUM	DIFFERENCE	AVERAGE
1. Plant No. 1. 2 samples. Analyzed by commercial laboratory. Jan. 1950.				
Moisture	4.99 b	6.09 a	1.10	5.54
Ash	5.33 b	6.99 a	1.66	5.16
Btu—as received	13,174 a	13,471 b	297	13,323
Btu—ash-moist. free	15,022 a	15,156 b	134	15,089
2. Plant No. 2. 7 samples. Analyzed by commercial laboratory. Dec. 1949.				
Moisture	2.69 b	8.96	6.27	5.97
Ash	5.78 b	11.10	4.70	8.08
Btu—as received	12,659 a (—)	13,920 b (+)	1,261	13,015
Btu—ash-moist. free	14,916 a (—)	15,313 b (+)	397	15,149
3. Plant No. 3. 2 samples. Analyzed by our own laboratory. Jan. 1950.				
Moisture	4.98 a	5.57 b	0.59	5.28
Ash	8.02 b	9.18 a	1.16	8.60
Btu—as received	13,035 b	13,042 a	7	13,039
Btu—ash-moist. free	15,085 b	15,193 a	108	15,139
4. Plant No. 4. 2 samples. Analyzed by our own laboratory. Feb. 1950.				
Moisture	6.44 a	6.56 b	0.12	6.50
Ash	7.64 a	8.15 b	0.51	7.90
Btu—as received	12,888 b	13,084 a	196	12,986
Btu—ash-moist. free	15,111 b	15,111 b	117	15,170

NOTES: Letters "a" and "b" refer to the same sample, for checking relationship. (—) and (+) indicate that the laboratory results may be low or high, since these are below or above normally expected results.

Table V. Analyses of Three Cars of Coal

Car	Moisture %	Ash %	Sulphur %	BTU Per Lb. As Rec'd.	BTU Per Lb. Ash-Moist. Free
1	5.46	12.98	0.48	12,596	15,443 (+)
2	2.60	9.57	0.51	13,534	15,410 (+)
3	6.95	19.10	0.53	11,260	15,227 (+)
Maximum Deviation	4.35	9.53	0.05	2,374	216

down the full gross sample run through the sample crusher into No. 4 mesh (approximately ¼ x 0) size. The sample crushers at plants 3 and 4 are located at the point of sampling the cars so that the jars are filled immediately upon sampling. The laboratory receives the samples within a few hours after sampling. No delay occurs at the laboratory so that chemical determinations are usually completed within 48 hr after sampling. Our plants 1 and 2 hand tamp their coal samples.

Samples have been received from outside sources in many unorthodox containers: from a few grams ground to 60 mesh sent in small paper envelopes to large jute sacks of coal. Drying, weathering oxidation, and other chemical changes may take place during shipment. Dependable and comparable results are very dubious in such cases.

ASTM standards prescribe methods of delivery of the sample to the laboratory. A sizable error can be introduced into the final analysis by improperly sending samples to the laboratory. This is particularly applicable where the moisture and volatile matter are high. The error shows up most prominently in the Btu determinations and where moisture corrections are involved.

C. Comparison of Laboratory Tests

In comparing analyses from different laboratories, even where there are no penalty clauses or fixed limitations on the coal quality, doubts are often raised between buyer and vendor.

Three cases of studies comparing results of coal determinations by a number of laboratories have come to the attention of the author.

Case 1. Eight samples of widely varying types of coals were received ground to 60 mesh, in small air tight jars. Thirteen laboratories ran proximate analyses on the 8 samples.

Table VI shows the variations from the average of all 13 determinations for moisture, ash, sulphur and Btu dry basis. A total of 104 determinations were made on each of the properties given. The smallest and greatest deviation from the over-all average for each property regardless of possible laboratory error is recorded.

A second average is recorded omitting the four determinations that were obviously in error. Two of these four plus one other high deviation item came from one laboratory. This serves to point out that the errors of one technician can affect a general average.

Case 2. In collaboration with Appalachian Coals, Inc., 27 samples of coal were analyzed by two commercial laboratories. Samples in ¼ x 0 size were received in sealed cans. The results are tabulated briefly as in Table VII:

The greatest number of deviations occurred in the two difficult determi-

Table VI. Comparison of Laboratory Results

Sample No.	MOISTURE Average 13 Labs.	MOISTURE Deviation Min.	MOISTURE Deviation Max.	ASH (Dry Basis) Average 13 Labs.	ASH (Dry Basis) Deviation Min.	ASH (Dry Basis) Deviation Max.	SULPHUR (Dry Basis) Average 13 Labs.	SULPHUR (Dry Basis) Deviation Min.	SULPHUR (Dry Basis) Deviation Max.	BTU PER POUND (Dry Basis) Average 13 Labs.	BTU PER POUND (Dry Basis) Deviation Min.	BTU PER POUND (Dry Basis) Deviation Max.
1	0.72	— .24	+ .25	9.32	— .45	+ .40	2.86	— .63	+ .42	13,643	— 141	+ 93
2	1.80	— .26	+ .50	18.43	— .33	+ .32	4.21	(— .75*)	+ .34	11,255	— 215	+ 148
3	0.38	— .16	+ .22	7.40	— .21	+ .25	1.34	— .29	+ .40	14,457	— 121	+ 123
4	1.62	— .46	+ .48	8.24	— .18	+ .16	2.89	— .49	+ .24	12,849	— 205	+ 161
5	2.21	— .63	+ .37	10.81	— .56	+ .32	3.18	— .54	+ .39	12,657	— 259	+ 171
6	3.97	(—1.17*)	+ .53	5.07	— .68	+ .55	0.53	— .22	+ .26	12,487	(— 527*)	+ 83
7	0.40	— .24	+ .19	7.84	— .38	+ .28	0.93	— .22	+ .27	14,417	— 40	(+ 1172*)
8	1.53	— .30	+ .23	12.94	— .23	+ .24	0.57	— .17	+ .08	12,664	— 194	+ 116
Average Deviation	1.95	—0.43	+0.34	10.01	—0.35	+0.32	2.06	—0.41	+0.30	13,053	— 213	+ 259
Average Omitting these in doubt*		—0.33								13,054	— 168	+ 117

ASTM Permissible Deviation:

Under 5% Moisture	—0.3	+0.3	Under 12% Ash	—0.5	+0.5	Under 2% Sulphur	—0.10	+0.10	0.5%	— 65	+ 65
Over 5% Moisture	—0.5	+0.5	Over 12% Ash	—1.0	+1.0	Over 2% Sulphur	—0.20	+0.20			

* Abnormal results.

nations of moisture under 5 per cent and the Btu per lb where the ASTM tolerances are very close indeed.

CASE 3. Report on 29 different laboratories analyzing 8 widely varying coals, totaling 1200 separate chemical determinations. The results are comparable generally with the data presented in Table VI. In fact the later figures are a continuation of the same type of study.

In Table VIII are the summarized results of these 1200 determinations, in terms of the ASTM tolerance, giving the deviation of the 29 laboratories from the Bureau of Mines analysis taken as the standard.

The types of coals used in this study varied from anthracite to high volatile bituminous. Two were West Virginia coals in which 22 out of 29 laboratories conformed in the Btu property, that is, 24.1 per cent exceeded the ASTM tolerances.

The study from which these figures are extracted seems quite comprehensive. It will undoubtedly come up with conclusions as to whether laboratory practices can be further improved to meet the ASTM tolerances or whether the tolerances need any adjustment.

It can be concluded that laboratory chemical determinations are generally dependable, especially after the reliability of the laboratory has been established. Greater errors can be introduced before the chemist starts his work.

Even where penalty clauses and limitations on coal properties are involved, I believe few analyses are brought to an accepted referee laboratory for composing differences in findings between buyer and vendor.

D. Can the User Check Coal Analyses?

Usually by the time the user gets his car sampled and analyzed, the coal has been unloaded. It may have been consumed and any resulting

Table VII. Deviation from ASTM Standards Between Laboratories

Property	Total No. of Samples	No. Exceeding ASTM Limits	Average Deviation of A from B	ASTM Permissible Deviation	Percent Exceeding ASTM Tolerances
Moisture					
Under 5%	11	10	—0.54%	0.3%	90.9
Over 5%	11	4	—0.46%	0.5%	36.3
Over 5%	5	1	+0.30%	0.5%	20.0
Ash	18*	0	—0.14%	0.5%	0
(As Rec'd.)	10	0	+0.15%	0.5%	0
Volatile Matter	8	2	—0.46%	1.0%	25.0
(As Rec'd.)	19	3	+0.49%	1.0%	21.0
Sulphur					
(As Rec'd.)	27**	2	+0.005%	0.1%	7.4
BTU per lb.	12	7	—85 BTU	65	58.3
(As Rec'd.)	15	8	+67 BTU	65	58.3
Totals	135	37			

* Both laboratories were identical on one sample.
** Both laboratories were identical on two samples.

Table VIII. Deviation from ASTM Standards on 1200 Determinations

Property	Percent Conforming to ASTM Tolerances	Percent exceeding ASTM Tolerances
Moisture	64.8	33.2
Ash (Dry Basis)	88.7	11.3
Volatile Matter (Dry Basis)	58.6	41.4
Sulphur (Dry Basis)	75.0	25.0
BTU per lb. (Dry Basis)	57.3	42.7

Fig. 3. Transfer table from main crusher to belt sampling tower

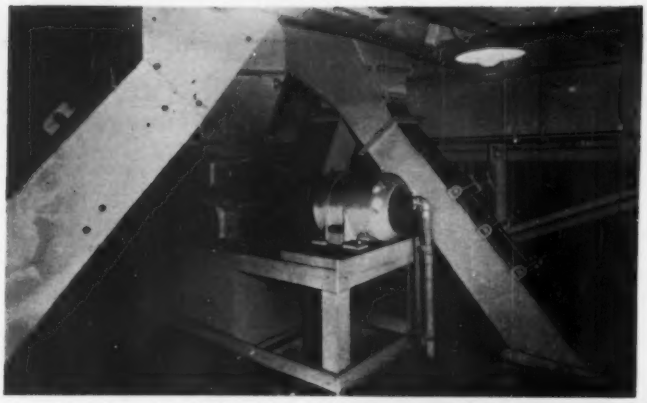


Fig. 4. (Above) Sample crusher with riffling and carry-away chutes

Fig. 5. (Right) Belt tripper above the boiler hoppers

damage done. It is probably the exception where cars are held up and spot sampled and checked with the purpose of rejecting cars found below prescribed standards. Discussion and loss of business usually come later.

At one time, a buyer of coal could get out his Bureau of Mines or other handbooks and check the characteristics of the coal from the location of the mine or its shipping point. But changes in mining methods and the introduction of preparation plants has rendered old records obsolete. Coals that ran 14,000 Btu as received ten years ago seem to have fallen considerably from that quality. Considerable improvement has recently been noted from many sources.

It has become necessary for users of large quantities of coal from probably many new sources to build up a historical record of each source and area for themselves, assembling a geographical record of coals by states, counties, seams, mines and shipping points whereby a coal can be judged from what has recently been received from that locality and source.

The ash-moisture free Btu of the coal, its inherent combustible value, has generally been used as the base. Variations in ash and moisture affect the as-received Btu value accordingly, but should not alter the ash-moisture free combustible heat value significantly.

Each seam and locality has its own characteristic combustible value, depending upon its content of oxygen, hydrogen, sulphur, carbon, and other elements that can only be determined by its ultimate chemical analysis. Such analyses are not readily available.

Once a base has been established for each coal, a chart can be made up showing the relationship of Btu content to moisture and ash. Figure 6 is such a chart for District No. 8 coals using 15,200 Ash-Moisture Free Btu as the base. By means of this chart, moisture and ash can be checked against "as received Btu" close enough for routine purposes. A curve for each type of coal would provide greater accuracy.

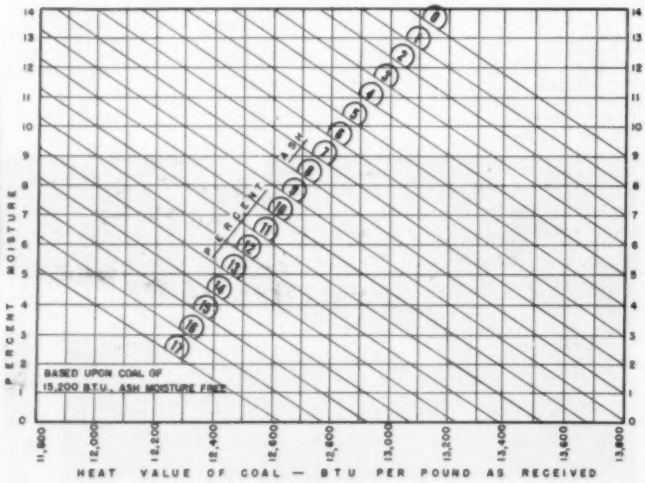


Fig. 6. Analysis check chart

E. Evaluation of the Analyses of the Coal

The evaluation of a coal depends upon the method of firing—stoker or pulverizer; the type of boiler-coal fusion and sulphur limitations; and the type of stoker—caking and ash limitations. Pulverizer capacities may require high grindability. I shall touch briefly on some of the properties of coal used in evaluating its laboratory analysis:

1. Btu Content. The primary importance of the highest Btu content of coal has lost some of its significance with the advent of high prices, increased freight costs, and apparent scarcity of certain types of coal. Many large users are now looking at the cost per million Btu as received in the boiler, rather than asking, "What seam or mine is it from and what is its f.o.b. mine price?" This is especially true of those plants whose boilers can utilize a range of coals. Basically, however, the Btu as received is looked

upon as the fundamental quality of the coal. It is most important to the men firing the coal. Coal buyers undoubtedly evaluate this property first.

2. Ash Content. Both cost and means of ash disposal have assumed greater importance as pulverizers have replaced stokers. The disposal of stoker cinders is no problem today. In fact cinders often can be made a source of revenue. Available dumps for fly ash are being filled and hauling distances are becoming longer and longer. Many pulverizer and spreader stoker plants are finding fly ash problems looming under new smoke abatement regulations. The freight cost of hauling excess ash in the coal, not only as a useless but as a troublesome material adds to the undesirability of high ash figures on the laboratory report sheet.

Mechanical mining and greater seam removal worsened the figures as the illustrative figures of this presentation will have shown. The rectification of this ash condition by means of good coal preparation is now putting the ash in coal from many sources, down where it belongs.

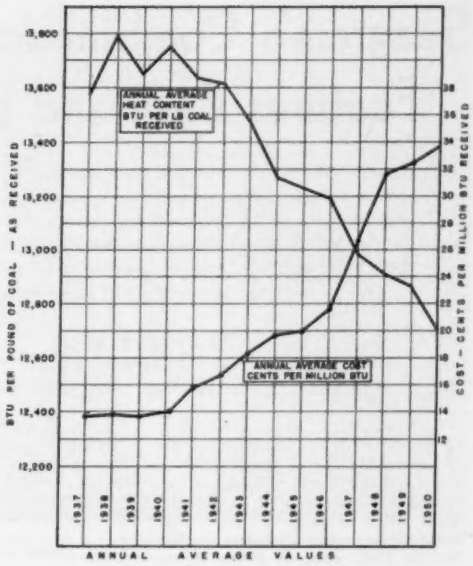
3. Sulphur Content. High sulphur coal has generally been avoided when low sulphur coals are available. Boiler plants are becoming more complicated with many expensive heat exchangers and coolers that bring the flue gases down below their dew points and permit the formation of corrosive liquids. High sulphur usually also means low fusion ash. Hence, everything else being equal, low sulphur values will be favored.

4. Fusion. The fusion characteristics of the ash of a coal are very important items on the laboratory report. The softening point is a determining factor in the value of the coal for a given method of firing and for the design of the boiler system involved. A minimum softening point is generally set as a definite limitation on usability of the coal.

5. Moisture Content. Moisture content is important in the winter time to plants located in freezing areas. The use of chlorides is not accepted by us. Cars of coal containing moisture over 6 per cent frequently bring complaints from the plant when unloading the coal. Moist coal sticks to the cars, rusts the equipment, jams the pulverizers and becomes a general nuisance to the operators. It costs money to pay its useless freight.

6. Hardgrove Grindability. Hardgrove grindability is a big factor in pulverizer plants which due to the lower heat content of present day coals, must boost their coal feeding to the limit of the capacity of the pulverizers to generate the required steam. Fortunate is the plant that had excess capacity and motor size as well as the proper type of mill.

Fig. 7. Annual average values



7. Swelling Index. For certain methods of firing, such as underfeed, chain grate and some other special types of stokers, where the caking properties of the coal have some bearing on the particular firing characteristics desired, the swelling index may become a valuable laboratory guide. We have made swelling index tests on many coals but have not as yet considered evaluation of these findings important. These values may have significance to some users.

It can be a quick laboratory test on the caking qualities of the coal to serve as a preliminary car evaluation test for certain properties of the coal as they fit individual operating requirements.

F. Need for Care by User in Selecting Coal

The firing of improper coals during the emergency period of the past year has caused considerable trouble to many plants. Where such coals get into the storage pile it might take some time before errors are discovered. It is then difficult to place the blame on the proper source of the bad coal and to void the offending contract.

There is no doubt that some coal producers have deserved criticism for developing the need for care by users in selecting their coal. There have been many cases where the coal actually shipped was far below the quality expected by the user

(Continued on page 124)

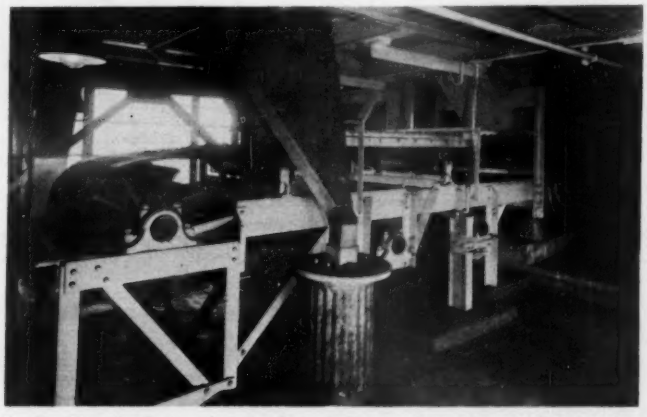


Fig. 8. Chute for final crushed riffled sample into catch can from which sample jars are filled

Seagram's Combination Boiler-Spray Drier Features Ease and Economy of Operation

Here, right from the men who have operated it, is the first account of one of the most unusual integrated boiler and process operations in industry . . . It is the combination boiler-spray drier unit, installed 3½ years ago at the Lawrenceburg, Indiana, distillery of Joseph E. Seagram and Sons, Inc. . . . Detailed in March 1946 issue before completion . . . In this article, the authors review the principal details of both boiler and spray drier, review reasons for using spray drier, explain problems solved in developing combined operation of boiler and drier, and economies of the operation

By **CYRUS R. BUCK**, Utilities Superintendent and **NELSON ROBERTS**, Development Engineer
Joseph E. Seagram & Sons, Inc., Lawrenceburg, Indiana

THE EXPANSION program of the Joseph E. Seagram and Sons plant at Lawrenceburg, Indiana, included a boiler and flue-gas-heated spray drier. This power plant and spray drier were described in the March, 1946, issue of *Power Plant Engineering* (now POWER ENGINEERING), prior to the completion of the unit. This unit, which is the first of three, has been in operation for approximately 3½ years. After 2 years of development work, the spray drier has proved to be an excellent and economical means of drying concentrated stillage to a valuable by-product. The outstanding features of this installation are the ease of operation and the negligible effect of the spray drier on the economy and operation of the boiler.

Boiler and Auxiliaries

The boiler used in conjunction with the spray drier is a 4-drum, vertical, bent-tube, Combustion Engineering unit operating at 425 psi with a normal capacity of 125,000 lb per hr of steam. Designed specifically to supply flue gas for use in spray drier operations, the boiler is normally fired with pulverized coal, which is ground in two Raymond bowl-type pulverizers. Each pulverizer has a capacity of 9780 lb per hr of coal. The unit is also designed for oil firing and is equipped with Coen steam-atomizing oil burners for either light loads or rated capacity if required. Preparations are now being made for natural gas firing of this boiler. It is planned to use gas in this boiler whenever possible. The furnace is completely water cooled and contains 9160 sq ft heating surface designed for a heat release of 16,000 Btu per sq ft per hr. At ratings from 70 per cent to 120 per cent, the boiler is designed to

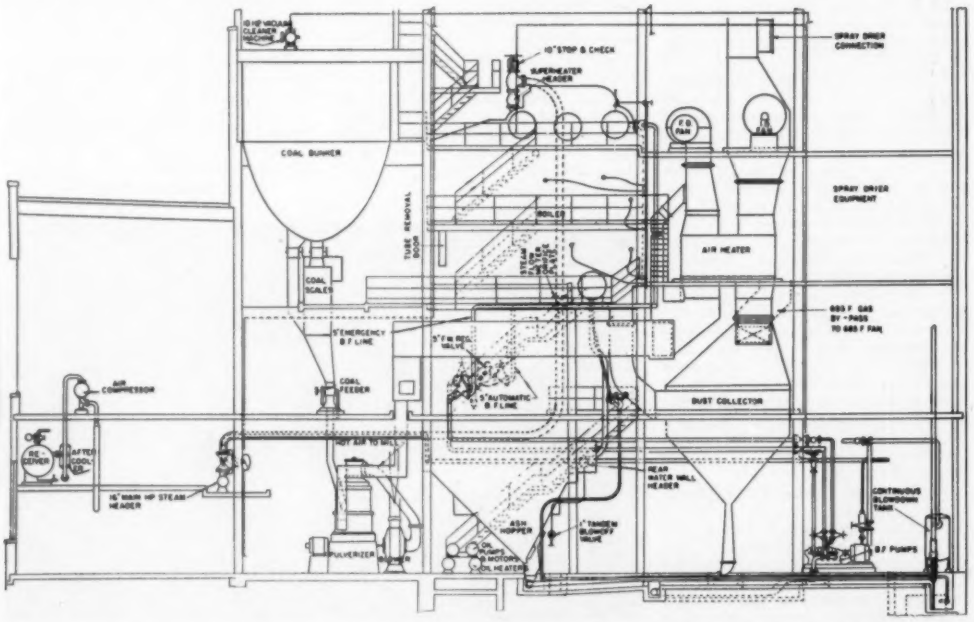


Fig. 1. General cross-section of boiler room at Lawrenceburg, showing first boiler and auxiliaries, also connections for supplying boiler flue gas to spray drier as shown in Fig. 4

have an outlet flue gas temperature of 650 to 700 F. This furnace outlet temperature furnishes flue gas of the correct final temperature for the spray drier.

How Boiler Flue Gas is Supplied to Spray Drier

The most interesting features of this installation are in the arrangement of the ducts and auxiliary equipment for use with a spray drier. The three standard elements: air preheater, dust collector, and induced draft fan are employed, but have an arrangement to permit the withdrawal of flue gas at both 700 and 350 F. Figure 4 shows the distribution of flue gas leaving the boiler.

The flue gas leaving the boiler passes first into the Prat-Daniel dust collector located at the boiler outlet. It is a Valmont tubular-type collector with additional velocity cones attached to the base of the precipitator tubes to increase the efficiency of the collector. From the discharge duct of the dust collector, a portion of the flue gas is drawn off by a separate fan to provide 700 F gas for the spray drier system. The remainder of the gas passes through a Ljungstrom air preheater with 30,300 sq ft heat exchange area, which reduces the temperature of the discharge gas to 350 F. A 250-hp Thermix induced-draft fan draws the flue gas from the preheater for discharge to either the spray drier or the atmosphere. The intake for the 350 F gas duct to the spray drier is located just above the induced-draft fan, before the flue gas enters the Thermix stack.

Distillery Operations and Functions of Spray Drier

To understand the problems and product of the spray drier, a basic understanding of the distillery process is necessary. Distillery operations are essentially a process of producing beverage spirits from grain starch, usually corn or rye and barley malt, and subsequent separation of the beverage spirits from the fermentation medium.

The process used at this plant is as follows: The grain is ground in hammer mills, mixed with water and cooked in a continuous cooker with steam at relatively high temperatures and pressures for a short period of time. This process breaks down the starch granules of the grain, so that the starch can easily be converted to fermentable sugars by the addition of barley malt, the enzymes of which convert the grain starch to sugars. The cooled, converted mash is placed in large fermenters where pure culture yeast is added. The yeast converts the sugars into alcohol and carbon dioxide.

After complete fermentation has taken place, the fermented mash, called "beer," is fed to multiple-column continuous distillation units where the alcohol is removed from

Fig. 2. View on boiler operating floor, showing boiler front, pulverized coal and oil burners, coal feeders, boiler control panel

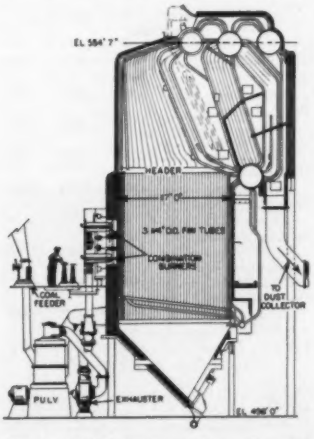


Fig. 3. Detailed cross-section of boiler installed as in Fig. 1

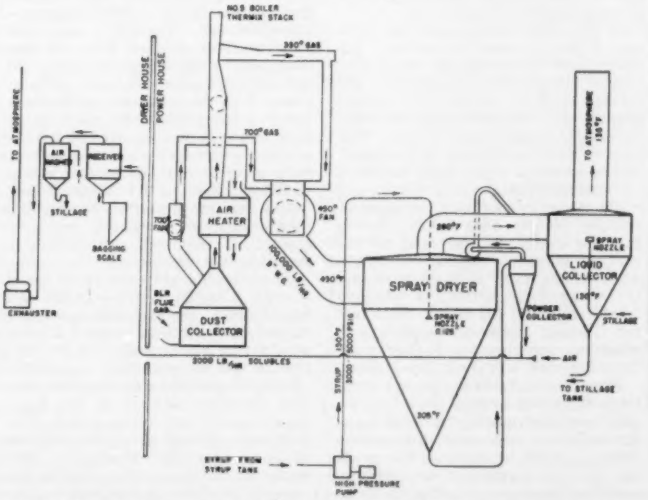


Fig. 4. Schematic diagram showing how flue gas from boiler is supplied to spray drier, how gas temperatures are controlled, how syrup is supplied to drier and final products removed—all as explained in text

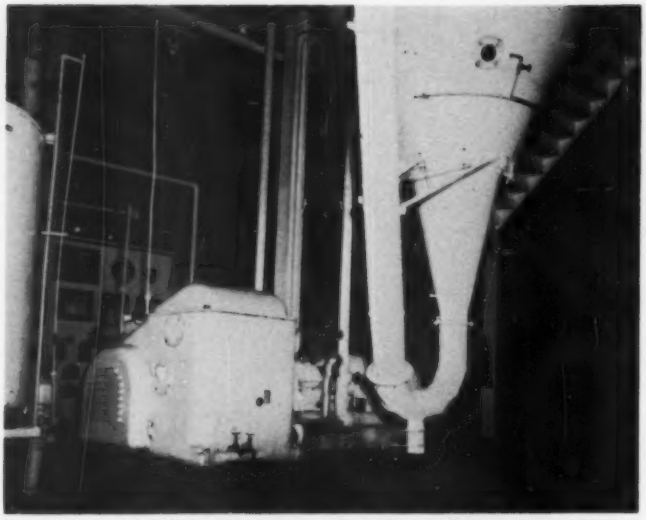


Fig. 5. Bottom part of main cone of spray drier, showing high-pressure triplex pump supplying syrup to spray nozzles. At rear, control panel for spray drier

the beer and purified to make either whiskey or spirits. The residue from the base of the beer stills contains approximately 7 per cent solids, principally fiber, proteins, corn oils and yeast.

Before the introduction of modern distillery methods, this residue, called "stillage" was fed to cattle at or near the plant, or wasted to the sewer. In all cases, the residue presented a serious waste disposal problem. However, it was found that stillage could be dried to produce a valuable animal-feed supplement and now all progressive distilleries operate by-product recovery units known as drier houses.

In the recovery process, the stillage is first screened to remove the fibers and other coarse suspended solids. The portion remaining on the screen is then pressed to further dewater it. This press cake is dried in rotary steam tube driers. The liquor from the screens and presses, which contains 3 per cent solids, is concentrated into syrup by quadruple-effect evaporators, to approximately 30 per cent solids. Syrup may be added to the feed of the rotary driers to make "distillers dark dried grain," or dried separately in the spray drier, to produce "distillers dried solubles." This latter product, richer in proteins and vitamins, commands a higher price than the distillers dark dried grain.

Previous methods for drying syrup such as steam-heated drum driers, produced high quality feed, but these driers have a very poor steam economy. In order to improve this process for the production of distillers solubles, Seagram installed the flue-gas-heated spray drier. This spray drier has proved to be an excellent method of processing, producing solubles of superior quality from heat that in other installations would, for the most part, be lost out the boiler stack.

Problems Encountered During Development Operations

Because this was the first installation of its size to use boiler flue gas for drying solubles, very little was known as to the actual operating conditions that would prevail. During the first runs, the product was very dark and was found to contain approximately 25 per cent ash. Since the solubles normally contain approximately 7 per cent ash, the flue gas was suspected of containing considerable ash. Therefore the dust collector was studied first. It was designed to have approximately 90 per cent collection efficiency with no more than 60 per cent of the ash being smaller than 44 microns in size. Since particle sizing is the critical factor in dust collector efficiency, tests were run to determine sizing of the ash leaving the boiler. It was found that the flue gas entering the dust collector contained approximately 92 per cent ash that was smaller than 44 microns.

Experiments were set up to see if it were possible to increase the ash particle size. Several different types of coal were burned, to see if it were possible to increase the ash particle size in this manner, but very little change in particle size was observed. The classifier settings of the Raymond pulverizers were adjusted so that only approximately 70 per cent of the coal passed through a 200-mesh sieve. Even this change has very little effect on the particle size of the flue ash produced. The results indicated that the difficulty was in the dust collector and was caused by turbulence in the collector hopper and by too low gas velocity through the collector tubes.

In order to further increase the efficiency of the collector the following changes were made:

1. All the sections of the dust collector were completely sealed between hoppers to prevent unstable conditions.

2. Velocity cones were placed on the bottom of the precipitator tubes to improve separation.

3. Sufficient tubes were blanked to increase the pressure drop across the collector to approximately 2.75 in. of water, which gave high velocities and improved the separation. After completion of these changes the ash content in the spray drier solubles was reduced to less than 9 per cent, which is considered satisfactory.

For the most economical boiler operations, the CO_2 content of the flue gas should be approximately 14.5 per cent. However, it was found that considerable carbon was being carried over in the flue gas and that this gave the product a greyish tinge. By adding excess air (lowering the CO_2 content of the flue gas to approximately 13.5 per cent), the excess carbon content disappeared and the color of the product improved.

During sootblowing and cleaning of the air heater, the spray drier must be shut down and fans turned off. This is necessary to prevent excess ash getting into the ducts, since the dust collector cannot adequately handle the amount of ash cleaned off during this operation. The main spray drier cone must be cleaned every 8-10 hours to remove particles that may have adhered to the side; so, with coordination, these two operations can be performed simultaneously.

The boiler is controlled automatically by Bailey controls, capable of

Table I. Typical spray drier operating conditions

Inlet Gas Temp., °F..	455	493	453
Drier Cone Temp., °F	306	306	309
Drier Outlet Temp., °F	256	273	274
Liquid Collector Stack Temp., °F.....	130	135	132
High-Pressure Pump Pressure, psi	4900	2800	2800
Vane Sweep Speed, r.p.m.	22	22	24
Solubles Produced, lb/hr	1980	2040	2160
Evaporation in Drier Cone, lb/hr	5670	5010	4770
Evaporation in Liquid Collector, lb/hr	3810	4440	3860

Table II. Typical chemical analyses of spray-dried solubles, as received basis

Moisture	1.6%	2.2%	1.1%
Ash	8.8%	8.2%	8.3%
Proteins	33.6%	33.5%	33.1%
Fats	13.9%	14.1%	12.9%
Fibers	8.6%	10.2%	8.8%

handling swinging loads such as are encountered in distillery operations, and yet maintaining uniform furnace condition. However, it was found that a steady load on the boiler greatly assisted the fireman in maintaining a clear furnace with a resulting consistent color of the spray drier product. When oil firing the boiler through steam atomizing burners, with approximately 15 per cent excess air, the solubles contained only the basic ash content.

The amount of flue ash leaving the dust collector is directly proportional to the ash content of the coal and therefore it is desirable to use low-ash coal. Because of river transportation, West Virginia coal, which is low in ash content, is economically available in this area. Therefore the necessity of using low ash coal is not an objectionable feature.

Spray Drier and Gas Flow

The 350 and 700-F gas ducts from the boiler join and discharge into a mixing chamber on the inlet of the fan which forces the flue gas through the spray drier. One hundred thousand pounds per hour of gas at 450 F is forced through the drier by a Sturtevant fan designed for these conditions.

The spray drier itself, Figs 4, 6 and 7, is a Swenson Gray-Jensen unit, with an 18-ft diameter main cone and 12-ft diameter liquid collector cone. The main drying cone consists of an inverted conical section approximately 20 ft tall and 18 ft in diameter at the top section. Above the conical section is a cylindrical section 9 ft tall. (See Fig 4.) This cylindrical section of the drier contains louvers around its circumference through which the incoming gas passes. A helical box around the outside of the cylindrical section connects with the gas inlet duct from the main spray drier fan.

A small powder transfer duct leads from the base of the drier cone to a powder collector and exhauster fan. The powder collector discharges into an Airveyor product conveying system.

The large duct from the top of the drier cone leads to a liquid collector, which is in turn vented to the atmosphere through a stainless steel stack.

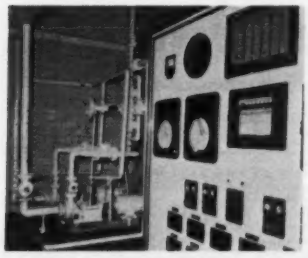


Fig. 8. At right is control panel for spray drier; at left, liquid collector pumps

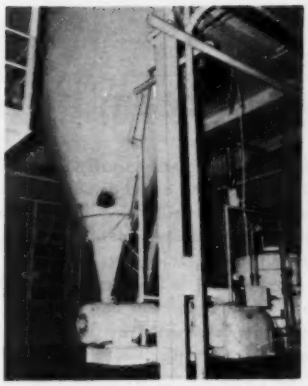


Fig. 6. Another view of bottom of main cone of spray drier from opposite side; high-pressure pump at base of cone

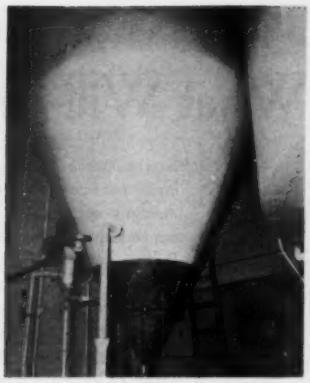


Fig. 7. Lower part of liquid collector (following drier as in Fig. 4) with level control to maintain liquid level constant

Evaporator syrup is pumped to the spray drier by a steam-driven piston pump which also supplies syrup to the rotary drier operation. This syrup is fed into a Manton-Gaulin high-pressure, electrically-driven triplex pump, Fig 6. This pump has a variable-speed hydralic drive regulated by a controller that maintains a constant temperature in the base of the drier cone. This temperature at the base of the drier cone has been found to be the most sensitive indicator of conditions in the drying chamber. By regulating the syrup flow to the drier and consequently the amount of evaporation done in the drier, it is possible to maintain a uniform product quality.

Syrup leaves the high-pressure pump at 4000 to 5000 psi and passes through high-pressure pipe to the spray assembly inside the main drier cone. This spray assembly is located in the center of the drier main cone, at the break from cylindrical to conical sections. The syrup passes through a whizzer, which imparts a violent spinning motion to the syrup stream, and continues through a nozzle which gives a solid cone spray of extemely finely-divided syrup droplets. The direction of the spray is downward into the rising gas stream. This gas enters the drier through the previously mentioned louvers and follows the normal cyclone patterns through the cone. Dried solubles fall to the bottom of the cone and are transferred through a duct to the powder collector. An air lock at the bottom of the collector feeds into an Airveyor, which carries the product to a bagging machine.

The gas leaving the drier goes through a duct to the liquid collector, where the gas is scrubbed with a hollow cone spray of thin stillage, which removes the solids that carry over from the main cone and further reduces the temperature of the gases, thus reclaiming more of the available heat in the gases than can be utilized in the main drier cone itself. The stillage from the liquid collector base is returned to the evaporator feed with increased solids and, therefore, lightens the load on the evaporators.

Boiler Efficiency Loss Caused by Spray Drier Operations

The gases from the boiler and auxiliaries would normally be discharged to the atmosphere at 350 F. Since the spray drier requires 450-F gas, there is some loss in boiler efficiency, for less heat is returned to the furnace from the air heater. The following calculation gives an approximation of the over-all loss in boiler efficiency:

$$\frac{100{,}000 \text{ lb/hr gas} \times 0.25 \text{ Btu/deg} \times (450 \text{ F} - 350 \text{ F})}{\text{Total Btu (1204 Btu} \times 125{,}000 \text{ lb steam)}} \times 100\% = 1.66\%$$

Such a loss is considerable unless one considers the other methods of drying. This amount of heat would produce approximately 2000 lb of steam per hour, which would be used in a steam tube rotary drier for similar drying. In a rotary drier an evaporation of approximately 0.75 lbs of water vapor per pound of steam is obtained. With 2000 lb of steam, approximately 1500 lb of evaporation would be obtained. The same amount of heat to the spray drier will evaporate approximately 7500 lb per hr, as shown in Table I.

Spray-dried solubles are of a golden tan color and have a fine powdery texture. Since the product is somewhat hygroscopic, it must be packaged in waterproof-lined bags. Research is now being conducted at the Seagram Experimental Farm to determine the feeding chracteristics of spray-dried solubles. Results to date indicate that these solubles are at least equal and possibly superior to other distillers solubles as an animal feed supplement.

What Will Future Steam Power Plants Cost?

By the method given here, you can make an estimate—an educated guess—of the investment cost of a future power plant, based on published costs of similar plants . . . Analysis of principal design factors influencing power plant costs . . . By using conversion factors based on accepted cost indexes, adjustments for individual design factors are made . . . These convert actual costs of existing plants to 1948-49 levels, to which can be added allowance for further increases . . . By doing this for existing plants similar to proposed plant, investment cost of latter can be estimated . . . A typical proposed plant, to be constructed by the end of 1952, is analyzed by this method and results tabulated . . . Author was for years Engineer of Steam Design, Dept. of Water & Power, City of Los Angeles; is now a consulting engineer in that city

By **WILLIAM C. ROWSE**, Consulting Mechanical Engineer

WHILE nothing will take the place of a careful, detailed estimate of investment cost of a proposed steam electric generating station, it is very helpful and convenient for the engineer to have available some data on investment cost per kilowatt for installed capacity, when he is called on unexpectedly or on short notice for an estimate of cost, and also for use as a general check on the detailed estimate.

To estimate the probable cost of a specific power plant proposed for construction in the near future, one must know what similar plants cost in the past. Then if adjustments could be made to these cost figures to bring them up to date, some estimate could be made of the new plant costs.

Now there is a wealth of published data on costs of power plants built during the past 10 years or so. But these plants were built during different cost periods and have different design characteristics. However, the following procedure has been worked out by the writer:

1—From accepted cost indexes, calculate conversion factors to convert costs from any construction period to 1948-1949 cost levels.
2—Then list principal design factors affecting steam plant costs.
3—Next adjust, by use of the conversion factors, the cost per kilowatt of each factor for 1948-1949 levels for plants similar in design factors to the proposed plant.
4—On the basis of these data, estimate the cost of the proposed plant at 1948-1949 levels, then add an estimated percentage for the period in the near future during which the proposed plant is to be constructed, thus arriving at an estimate of its total cost.

This article is a summary of a study made by the writer along these lines. It presents the principal factors affecting steam plant costs

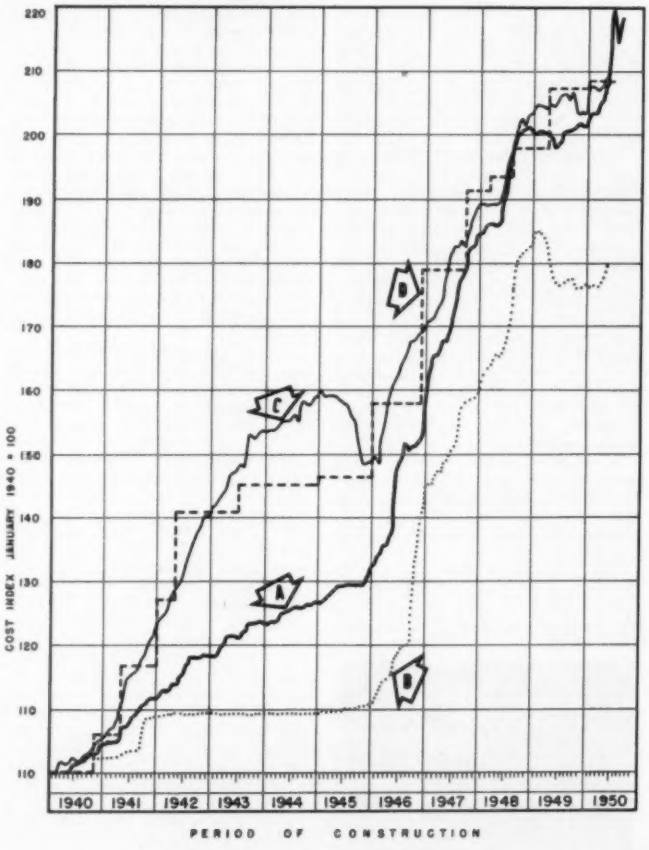


Fig. 1. Cost Indexes: January 1940 = 100

A—From Engineering News-Record Construction Cost Index
B—From Wholes Price Index, Metals and Metal Products, published by U. S. Bureau of Labor Statistics
C—From Average Hourling Earnings in the Durable Goods Industry, published by U. S. Bureau of Labor Statistics
D—Index of Average Hourly Earnings of Construction Labor on Steam Plants in Los Angeles area—Calculated by William C. Rowse

and, where possible, gives figures indicating the magnitude of each factor. Then, by an actual example shown in Table II, it illustrates how an estimate of cost of a proposed plant is made by adjusting the costs of five plants of similar characteristics built at different peroids.

The study is confined to investment cost, and wherever the term "cost per kilowatt" occurs it is understood to mean "investment cost per kilowatt of installed capacity, manufacturer's rating, based on a design for 25 per cent overload," except where otherwise stated.

Unless otherwise stated, all cost figures in this article refer to the conventional totally-enclosed steam plant of three or more units, each having a manufacturer's rated capacity of 60,000 to 75,000 kw.

I — Construction Period Factor

Costs have increased so rapidly during the last ten years that only the costs of plants constructed during the same period of time are at all comparable. Figure 1 presents several cost indexes all referred to the same base, namely January 1940 equals 100, from which it may be seen that costs have doubled in the last decade. The costs tended to level off during the two-year period of 1948 and 1949. For the purposes of this article, all costs quoted were converted to this period for ease of comparison by the use of Fig. 2 which shows conversion factors by means of which costs for any other period may be converted to the 1948-1949 cost level. Figure 2 was calculated by dividing the average of the indexes shown on Fig. 1 for the two-year period 1948-1949 by the averages of the same indexes for each two-year period (the usual period of construction) and plotting each resultant conversion factor on the ordinate between the two years. Two conversion factor curves are shown because both are in general use although the writer used curve "X" in calculations for this article.

II — Design Factors

Costs are affected by design factors depending on kind and price of fuel, steam pressures and temperatures and cycles, nature of load, size and number of units, number of boilers per turbine, local conditions affecting structures and supply of condenser cooling water, and on other factors. Each of these is discussed below.

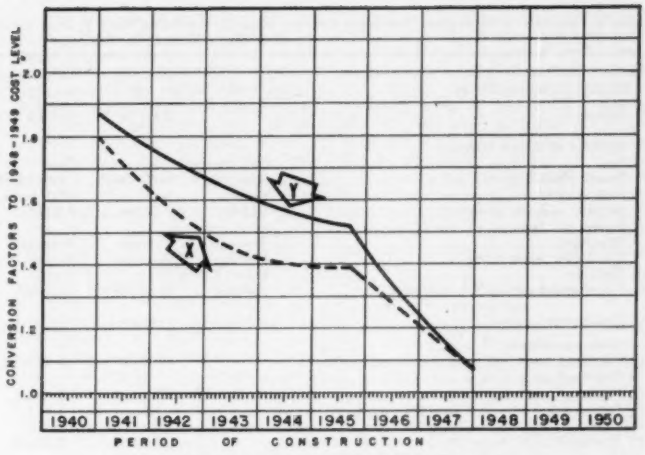


Fig. 2. Factors for Conversion to 1948-1949 Cost Levels
X—From Indexes B and C of Fig. 1, based on U. S. Bureau of Labor Statistics Indexes
Y—From Index A of Fig. 1, based on Engineering News-Record Index

Kind of Fuel

Fuel oil and gas are the simplest fuels to burn and require less investment than pulverized coal. The additional cost of a plant designed for burning pulverized coal only over the cost of a plant designed for burning oil or gas only may be divided into two parts:

(a) The additional cost of the larger furnace for coal with resulting additional costs for building, foundation, etc.

(b) The additional cost of coal handling and pulverizing equipment and ash handling equipment. The additional cost for the larger furnace may be taken at $3 per kw; the cost of coal handling and pulverizing equipment and ash handling equipment of the order of $15 per kw; and fuel oil storage and heating and pumping equipment of the order of $2 per kw; all at 1948-1949 cost levels.

Steam Pressures, Temperatures and Cycles

The increasing prices of fuel, improvements in the art of steam electric generation of power, including commercial availability of materials suitable for high temperatures, and low interest rates have justified more efficient design of steam plants. Where the 850-psi-900-F regenerative cycle was considered standard a few years ago, the 1250-psi-950-F regenerative cycle may now be considered standard with a strong tendency toward the 1450-psi-1000-F regenerative cycle. And the reheat-regenerative cycle has been used in a number of installations with even higher pressures and temperatures. The additional costs of each of these cycles over the 850-psi-900-F regenerative cycle should be carefully calculated by the engineer for use in economic studies, but for the purposes of this article may be taken as of the order of the following (all at 1948-1949 cost levels):

1250-psi-950-F
regenerative .....$ 4 per kw
1450-psi-1000-F
regenerative .....$ 6 per kw
1450-psi-1000/1000-F
reheat-regenerative ..$10 per kw

Nature of Load

The nature of the load may be of four different types, namely (a) normal system load factor, (b) base load, (c) peaking, and (d) spinning reserve. Economic studies of (a) and (b) would indicate steam pressure, temperature and cycle to use as discussed in the preceding paragraph. A peaking plant and a spinning reserve plant would probably both use the 850-psi-900-F regenerative cycle but there would be an additional cost for special design of the spinning reserve (for continuous operation at low load with instantaneous pickup of full load) over the peaking plant of the order of $2 per kw at 1948-1949 cost levels.

Size and Number of Units

The cost data available to the writer covers a range in size of units from 10,000 to 75,000 kw and indicates that, while theoretically a plant with smaller units should cost more per kilowatt than a plant with larger units, practically the increased cost

Table I Investment costs per kilowatt of installed capacity for a steam-electric generating station of four 75,000-kw units, based on assumed investment costs

Number of Unit	Period of Construction	Assumed Historical Costs		Costs Converted To 1948-1949 Cost Levels Using Curve X of Figure 2	
		Total	Per Kw	Total	Per Kw.
No. 1	1941-1942	$ 8,900,000	$119	$14,500,000	$193
No. 2	1943-1944	6,900,000	92	9,800,000	130
No. 3	1945-1946	7,400,000	99	10,000,000	133
No. 4	1947-1948	9,300,000	110	9,900,000	132
Total		$32,500,000	117	$45,200,000	151

Table II. Example of estimating investment cost per kilowatt, for Steam Plant X, from published costs of similar plants, and adjustments for principal factors affecting costs

Item							
1	PLANT DESIGNATION	X	Y1	Y2	Z1	Z2	Z3
2	Reference		Note A	Note B	Note C	Note D	Note E
	Analysis of design factors						
3	Fuel	Coal, oil, gas	Coal	Coal	Coal & oil	Coal	Coal
4	Steam conditions	1250#-950 F	850#-900 F	1250#-925 F	850#-900 F	850#-900 F	1250#-900 F
5	Nature of load	System	Base	With hydro.	Base	System	Base
6	Number and size of units	2-60 Mw.	2-60 Mw.	2-80 Mw.	2-60-74 Mw.	1-60-74 Mw.	2-60-74 Mw.
7	Boilers per turbine	1	1	1	1	2	1
8	Structures	Average	Average	Average	Average	Average	Average
9	Condenser water works	Average	Average	Average	Low average	Average	High average
10	Outdoor	Boilers & fans	None	None	None	None	½ boiler
11	Transformers and switching station	Included	Excluded	Included	Included	Included	Included
12	Construction period	1951-52	1941-44	1939-41	1940-44	1948-49	1948-49
	Costs per kilowatt						
13	Published costs incl. land		$102.00	$ 85.00	$102.95	$169.52	$162.80
14	Published costs of land		1.32	1.32	1.32	1.30	.76
15	Published costs excl. land		$100.68	$ 83.68	$101.63	$168.22	$162.04
16	Conversion factor to 1948-1949 cost level (from Curve "X"—Figure 2)		1.51	1.86	1.57	1.00	1.00
17	Published costs converted to 1948-1949 cost level		$152.00	$155.64	$159.56	$168.22	$162.04
	Adjustments per kilowatt for Plant X						
18	Fuel		$+2.00	$+2.00	$	$+2.00	$+2.00
19	Steam conditions		+4.00	+1.00	+4.00	+4.00	+1.00
20	Nature of load		....	....	....	....	....
21	Number and size of units		....	....	....	....	....
22	Boilers per turbine		....	....	....	—7.00	....
23	Structures		....	....	....	....	....
24	Condenser water works		....	....	....	....	....
25	Outdoor		—3.75	—3.75	—3.75	—3.75	—1.90
26	Transformers and switching station		+7.00	....	....	....	....
27	Total net adjustments		$+9.25	$—0.75	$+0.25	$—4.75	$+1.10
28	Adjusted costs per kilowatt at 1948-1949 cost level		$161.25	$154.89	$159.81	$163.47	$163.14
	Estimated cost per kilowatt of Plant X						
29	At 1948-1949 cost level	$160.00					
30	Add for 1951-1952 cost level (25 per cent)	40.00					
31	At 1951-1952 cost level	$200.00					

Note A: Steam-Electric Plant Production Cost and Annual Production Expense, 1938-47, by Federal Power Commission, Riverside Station, Baltimore, Md., and *Electrical World*, Aug. 18, 1945.

Note B: Steam-Electric Plant Production Cost and Annual Production Expense, 1938-47, by Federal Power Commission, Oswego Station, Oswego, N. Y., and *Electrical World*, July 12, Nov. 1, Dec. 13, 1941, and *Power*, Jan. 1942.

Note C: Fifth Steam Station Cost Survey, by A. E. Knowlton, *Electrical World*, July 3, 1948, Station No. 80.

Note D: Sixth Steam Station Cost Survey, by A. E. Knowlton, *Electrical World*, April 24, 1950, Station No. 127.

Note E: Sixth Steam Station Cost Survey, by A. E. Knowlton, *Electrical World*, April 24, 1950, Station No. 142.

Under adjustments for factors affecting costs, under Item 19, while Plants Y2 and Z3 employ 1250 lb steam pressure the steam temperature is lower than the 950 F to be used in the proposed plant and therefore a nominal adjustment of $1 per kw is made; and under Item 25, the saving for outdoor boiler and fan given in this article is $3 per kw of CAPABILITY which has been converted to $3.75 per kw of rated capacity by dividing by 0.8; also, since Plant Z3 has boilers which are only half outdoors, an adjustment of one half of $3.75, or $1.90, is made.

It will be noticed that, although the costs, excluding land, of plants actually constructed vary from $83.68 to $168.22 per kw, Item 15, the analysis presented on Table II produces costs at 1948-1949 cost level, Item 28, which are within about 3 per cent of the average of $160.50, which has been rounded out to $160.00 in Item 29 as the estimated cost per kilowatt of the proposed plant at the 1948-1949 cost level.

The amount under Item 30 which should be added to Item 29 to obtain an estimated cost per kilowatt at the 1951-1952 cost level is, of course, purely an estimate based on the engineer's best judgment backed by such facts as are available. By way of illustration, the writer notes that at the time of writing this article the *Engineering News-Record* Construction Cost Index for October, 1950, is 534.4, which is an increase of 66.4 over the two-year average for 1948-1949 of 468.0, or an increase of about 14 per cent. The prospect is for still further increases in costs, gradually levelling out due to governmental measures, some of which are already in operation. Therefore, by way of illustration, the writer has entered under Item 30 of Table II an addition of 25 per cent, or $40 per kw, to the $160 per kw at the 1948-1949 cost level, to obtain the estimated cost per kilowatt at the 1951-1952 cost level shown under Item 31.

per kilowatt is not as great as might be expected. The writer believes that this may be caused by the fact that, in smaller organizations, management and the engineer are closer to the actual design and construction and are in a position to hold costs down than is the case in larger organizations.

Likewise, generally speaking, the greater the number of units, the lower the cost per kilowatt for the same size of units and same cost level, because land and certain common facilities are included with the first unit and subsequent units are installed at a lower additional cost per kilowatt. The cost per kilowatt of the first unit of a new steam plant or the cost of an addition to an existing plant should be investigated and analyzed carefully before using for estimating purposes as discussed later.

Number of Boilers per Turbine

The trend is definitely toward one steam generating unit per turbine up to a capacity of 900,000 lb of steam per hour per steam generating unit. Some designers, however, prefer two half-size steam generating units per turbine, in which case the additional cost is generally estimated as 25 per cent of one steam generating unit and affected appurtenant investment including fans, boiler feed piping, boiler room building and boiler foundations, or of the order of $7 per kw at 1948-1949 cost levels.

Local Conditions as Affecting Structures

Under this heading one usually thinks of unusual foundation conditions although there may be many other conditions affecting the cost of structures such as a location requiring design against earthquake, a location adjacent to a river with possible flood conditions, etc. Each case must be the object of a special study.

Local Conditions as They Affect Condenser Circulating Water Supply

Some plants are so located that a new condenser circulating water supply system is installed complete with each unit as in a plant employing cooling towers. In some instances the plant may be located right on

the shore of a harbor, lake or river under conditions requiring a minimum investment for condenser circulating water supply, while in other cases it is necessary to construct long and expensive tunnels.

The cost of cooling towers with reservoirs and make-up water treatment equipment is of the order of $6 per kw at 1948-1949 cost levels. Any other means of circulating water supply will have to be estimated for each particular case.

In one case with which the writer is familiar the cost per kilowatt of condenser circulating water tunnels together with water front structures and pump chamber at the plant all constructed at the same time as the first unit, was approximately: $50 for one unit; $25 for two units; $17 for three units; $13 for four units; and $10 for five units; all at 1948-1949 cost levels.

Outdoor Plants

For a great many years steam plants were practically always completely enclosed; but, during recent years, an increasing number of plants have been constructed partially or completely outdoors, usually where the climate is mild. There are three general types of outdoor steam plants: (a) either turbine generators or boilers outdoors; (b) both turbine generators and boilers outdoors with auxiliaries inclosed; and (c) completely outdoors except for control equipment and delicate instruments. Approximate savings in costs over the conventional completely inclosed plant have been reported as follows[1] which may be assumed to be at 1948-1949 cost levels:

	Per Kilowatt of CAPABILITY
Either turbine generators or boilers outdoors	$ 3
Both turbine generators and boilers outdoors	$ 6
Completely inclosed	$10

III — Non-Comparable Costs

In studying published cost data, the engineer is usually interested in the cost of steam plants comparable to a steam plant he proposes to build and he must be on the lookout for non-comparable plants. There may be several non-comparable factors of considerable magnitude, two of which are large expenditures with the first unit for facilities to serve future units and low cost of units added to an existing plant because certain common facilities are already installed.

As an illustration, let us assume that a plant of four 75,000-kw units is constructed. The cost of the first unit includes land, condenser circulating water tunnels and other costly facilities sufficient for four units plus the cost of some minor facilities, such as fuel oil heaters and fire protection equipment, sufficient for two units. When the second unit is installed, none of the common facilities have to provided. With the third unit none of the major common facilities are required but some minor facilities for two units may be included. With the last unit, none of the common facilities already installed have to be provided but there may be other minor expenditures incidental to completion of the plant.

The costs per kilowatt of such a program are illustrated in Table 1 using assumed investment costs. It will be noticed that the costs per kilowatt vary widely and that the only correct cost is the cost of the completed plant. Sufficiently accurate costs per kilowatt could have been obtained by allocating the costs of common facilities among the four units.

While most reported costs do not include any transmission capital, sometimes step-up transformers and a high-tension switching station are included with the cost of the steam plant. Step-up transformers only will cost about $4 per kw at 1948-1949 cost levels, and this will be about doubled if both step-up transformers and high tension switchers are included.

IV — Interest During Construction

Sometimes interest during construction is included in investment cost and sometimes it is not included. The writer does not recall seeing any published costs which make an explanatory statement regarding this item. On the theoretical assumption that money is spent over a two year construction period at a uniform rate of expenditure, the total interest during construction would be the total cost multiplied by the annual interest rate. This interest rate in 1948-1949 ranged from two per cent per year to four per cent per year, the former for some municipally owned utilities and the latter for privately owned utilities.

Assuming an investment cost of $150 per kw, interest during construction per kilowatt would be $3 at two per cent to $6 at four per cent.

V — Rated Capacity

For many years practically all steam plants were designed for an overload of 25 per cent above the manufacturer's rated capacity of the turbine generator unit and all cost figures in this article refer to that method of rating. In recent years, two new methods of rating are being used, (a) the "preferred standards" with an overload capacity of 10 per cent over the manufacturers' rated capacity of turbine generator unit, and (b) continuous rated capacity with no overload capacity, the latter usually applying to base load units designed to operate continuously for 8000 hr per year at the maximum capability of the turbine generator unit.

While most costs have been reported on the basis of manufacturer's rated capacity, it appears that some costs have been reported on the basis of maximum capability and costs in this article on the basis of rated capacity with 25 per cent overload can be converted to costs per kilowatt of rated capability by multiplying by the factor of 0.8.

It should also be pointed out that in comparing costs of steam plants employing different steam pressures and cycles for economic studies the net station output capacity should be used.

Example to Show Application of Method

As an example, let it be assumed that a public utility plans to construct a new steam plant containing two 60,000 kw units designed for 25 per cent overload, to be ready for initial operation in December, 1952, and to have the following general characteristics; to burn pulverized coal, oil and gas; 1250-psi-950-F steam conditions; system load; one boiler per turbine; average conditions for structures; average cost of condenser water works; boilers and fans outdoors; cost to include step-up transformers and outdoor switching station. An estimate of cost is desired exclusive of land which has already been acquired.

The procedure is illustrated by Table II which is self explanatory except for the clarifying remarks given below the table.

Conclusion

Except where otherwise stated the cost figures given in this article are taken from studies made by the writer and, as mentioned at the beginning, apply particularly to steam plants of three or more units each having a manufacturer's rated capacity of 60,000 to 75,000 kw and designed for 25 per cent overload. It is expected that engineers applying these costs to their own particular problems will check the figures presented above with their own records particularly where the number and capacity of units are different.

JOSEPH R. DARNELL

JOSEPH R. DARNELL, consulting engineer and at one time Associate Editor of *Power Plant Engineering*, died in Milwaukee, Wisconsin, after a brief illness, on January 4.

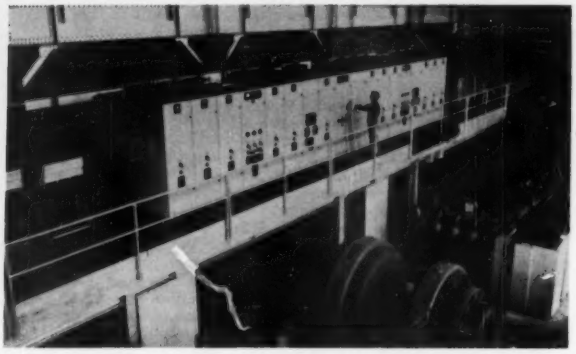
Mr. Darnell was a well known combustion engineer, having received his early training under Henry Kreisenger, when he was Assistant in the Fuels Section of the United States Bureau of Mines at Pittsburgh in 1918. He was the author of numerous technical papers and of the Boiler Fireman's Handbook.

A more complete obituary will appear in a subsequent issue.

[1] Operation and Maintenance of Outdoor Plants Found Practicable by R. M. Hanson, *Electrical World*, Oct. 14, 1948, pp 93-96.

Power Engineering

Above—Big splash as one of old 518 ft spans of Illinois Central Railroad Bridge at Cairo, Ill., is launched into Ohio River, being replaced by new span. Not a power plant job, to be sure, but an ingenious engineering feat. New span complete with rails erected on falsework alongside old; then the old span rolled onto sloping temporary falsework; new span rolled into place; then old span launched in river, to be reclaimed for scrap. All done in just 20 hours. U. S. Steel Corp. photo

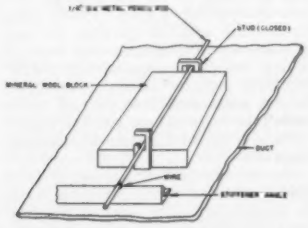


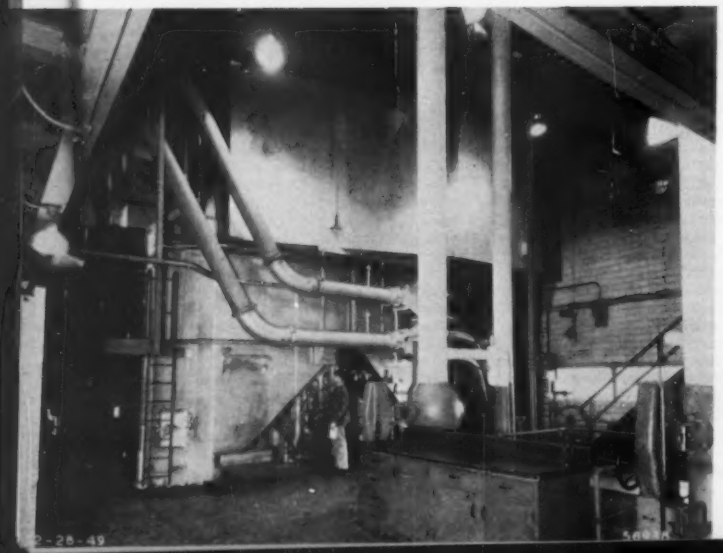
Above—View of blooming mill motor room of Jones and Laughlin's Otis Works at Cleveland, where largest metal-enclosed draw-out switchgear made by GE, for heavy-duty d-c service, has been installed. Consists of 18 breaker and control units for two 1000-kw 250-v ignition rectifiers, a 1500-kw 250-v m-g set and 12 automatic reclosing feeder circuits

Right—Charles R. Randell, Research Division, New York University, adjusts building model and three smokestacks built to scale for use in a new wind tunnel for investigation of stack gas dispersion

Left—The nation's first gas turbine locomotive at work on Union Pacific Railroad, where it has been road tested; turbine has operated nearly 5000 hr; burns Bunker C oil. Turbine is a 4500-hp unit with electric drive for locomotive, developed by GE and ALCO. UP has just ordered 10 more similar units

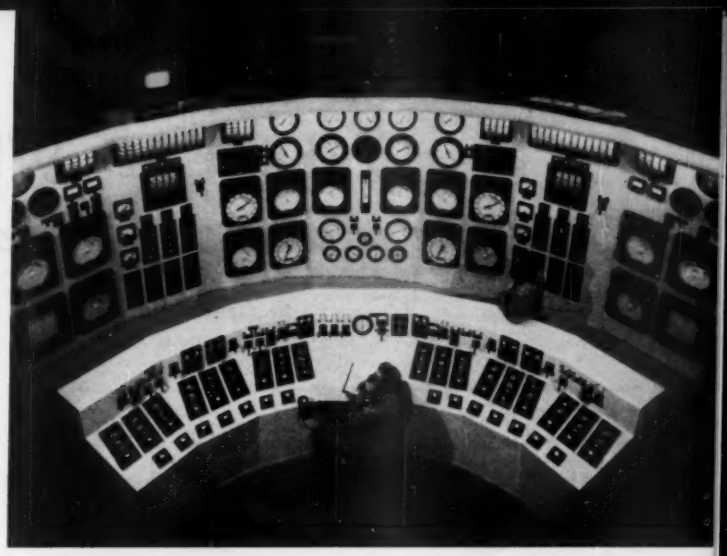
Below—Method of applying insulation to inside of duct shown at left:—Open rectangular studs welded to inside duct surface on 12-in. centers; mineral wool blocks slid between studs and butted; long metal pencil rods inserted to hold insulation; studs closed to hold rods. Stiffener angles on 24-in. centers welded to duct and pencil rods wired to them. Waterproof paint applied to insulation, then expanded metal lath and, last, 1-in. thickness refractory cement





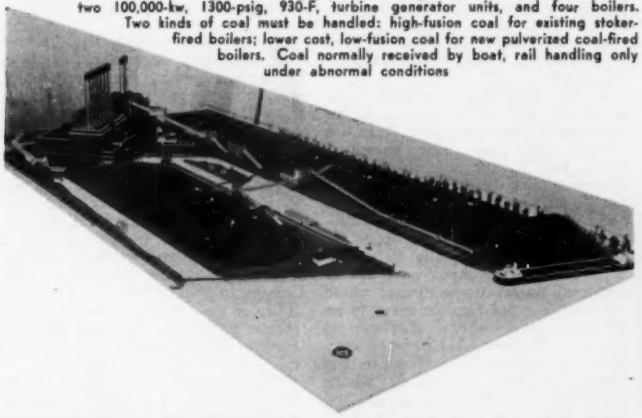
Left—Engineers of Public Service Electric and Gas Co. of New Jersey have applied insulation inside large secondary air ducts at 300,000-kw Sewaren Generating Station, to reduce possibility of expansion cracks and accidental damage. Maintenance costs cut to minimum; inspection once a year

NEWS REEL

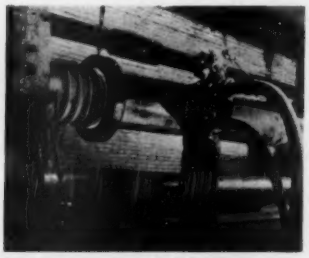


Right—Here's the boiler control center for cyclone-furnace Boilers No. 14 and 15 at new South Power Station of Dow Chemical Co., Midland, Mich.—photo not available when we described plant in September 1950 issue. It shows one of new trends in power plant control—separation of frequently-used operating controls from historical recorders and infrequent adjustments, aiding ease and efficiency of control operations. Utiliscope at upper left for observing hot slag drainage from cyclone furnaces. Benchboards and panels carry Republic automatic combustion controls for two new B & W steam generating units, fired with crushed coal by Cyclone furnaces, rated at 400,000 lbs. per hr. each, 1250 psig, 830 F., and supplying steam to processes through a 30,000-kw Westinghouse double-extraction turbine generator

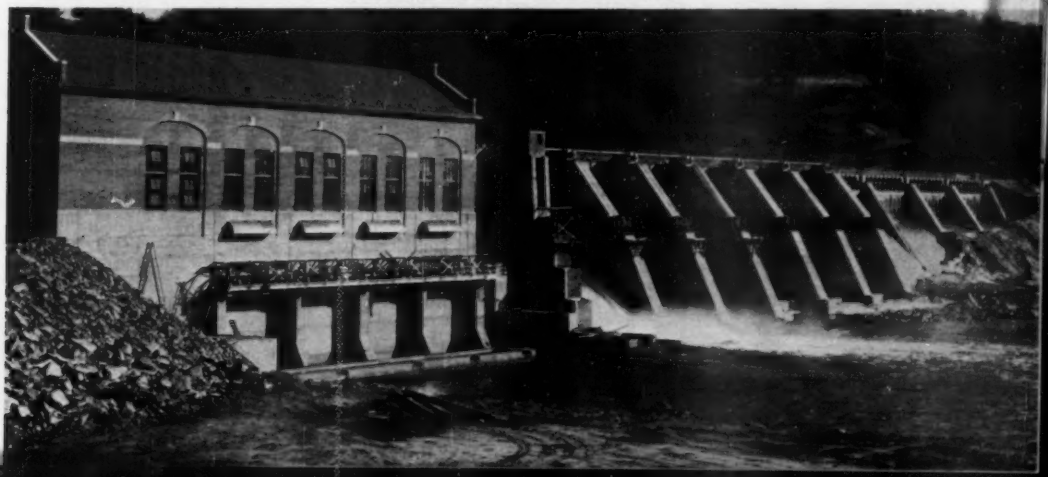
Below—Model of new coal handling system for Conners Creek Power Plant of The Detroit Edison Co. It was exhibited at *Power Engineering's* booth at New York Power Show last December. Plant is now being extended (by portion at right with two stacks) to contain two 100,000-kw, 1300-psig, 930-F, turbine generator units, and four boilers. Two kinds of coal must be handled: high-fusion coal for existing stoker-fired boilers; lower cost, low-fusion coal for new pulverized coal-fired boilers. Coal normally received by boat, rail handling only under abnormal conditions



Below—First 30-in. O. D., chrome-moly corrugated piping was formed at shops of the M. W. Kellogg Co. for use in exhaust steam line supplying 1,000,000 lb. per hr of steam from 60,000 kw topping turbine to low-pressure units at Hudson Avenue Station, Brooklyn. This corrugated piping designed to have 5 times flexibility of plain piping. Fabrication method used to prevent cracking



Below—On November 29, 1950, Wilder Station of New England Power Co. went on line. Plant is at White River Falls on Connecticut River between Wilder, Vt., and Lebanon, N. H. New plant contains two 16,500-kw generators driven by adjustable-blade propeller turbines. Details given in PPE, April 1947. This is a redevelopment; first plant at site about 1785; various other plants in subsequent years; present station replaces an old 5000-kw plant



OVERHEAD WIRES
and the Legal Limits of Liability

By ALBERT WOODRUFF GRAY

IN THE SUMMER of 1948 a workman in North Carolina was employed in the construction of the roof of a barn. One end of this barn was under a wire of the Duke Power Co., with a current at a potential of 7200 v. The workman went to that end of the roof, came in contact with the wire and was killed.

This conductor was 23 ft and 9 in. above the ground and the barn roof 17 ft and 11 in. from the ground. The wire was not insulated. The power company had received no notice of the construction of this barn nor of the proximity of its roof to the wire.

The consequent lawsuit against the power company for negligence was based on this lack of insulation and the failure of the company to post warnings of this danger from the absence of insulation.

The court disposed of the first contention by refusing to hold the company negligent for lack of insulation on the authority of an earlier decision by a Mississippi court that the duty to provide insulation was restricted to points where there was reason to believe persons might come in contact with the wires.

In the Mississippi decision from which this rule was adopted, a workman had pulled a well pipe from the ground until the pipe extended thirty feet in the air. Instead of dis-assembling the pipe and removing it joint by joint, the upper end had hit a tension wire and the workman had been killed. Refusing to hold the power company liable for negligence in the occurrence of the accident, the court said that while the law does not require wires to be insulated everywhere, if there is reason to believe that persons may come in contact with them in the pursuit of their calling or where they may be expected to go, the wires should be protected in some manner.

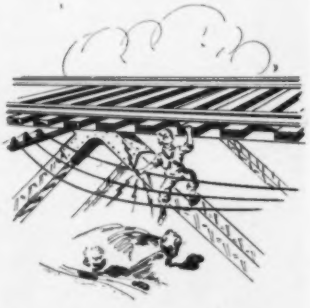
Of the omission of danger signs in the North Carolina case the court also held that there was no negligence on the part of the power company. "Here again no duty arose unless the power company knew or reasonably should have known that there was danger of persons coming in contact with its wires. If the company had known that the county was erecting a barn on the company's right of way, some such duty might have been imposed upon it, but that is not the case."

In the application of this rule of liability to children another factor occurs—the irresponsibility of the children and the lack of the caution that is a feature of the conduct of adults. Such an instance came before the Federal Court of Appeals three months before this North Carolina decision was made in favor of the Duke Power Company.

A twelve year old boy crawled onto the steel superstructure of a bridge along which had been strung, well above the roadway, a power wire. The boy became dizzy, grabbed hold of this power wire with its 2300 v and was seriously injured.

The rule of negligence laid down in this case by an Iowa court was that while the company must exercise care in handling and controlling a dangerous instrumentality of this character and while it was not an insurer against injuries to those coming in contact with its wires and if under the circumstances it had no reason to believe or anticipate that another would come in contact with its wires, it was not negligent.

The question of whether or not it had reason to anticipate such an accident was left by the court to the jury for determination with a charge that was approved on appeal to the Federal Court of Appeals. "In considering whether the company was negligent you are limited to a determination of whether in the exercise of reasonable care and dili-



gence the company should have known that boys are likely to use the superstructure of the bridge to climb upon and to come in contact with the wires of the company."

The verdict of the jury against the company was sustained. The exercise here by the company of this "reasonable care and diligence" had fallen short of that demanded by the law in the protection of children.

The power company in this instance also based its defense of negligence on its compliance with the safety rules of the United States Department of Commerce which the court here refused to consider.

Obedience to these same rules, however, served as a complete defense in a negligence action brought in Louisiana against the Gulf States Utilities Co. Four or five miles outside Baton Rouge the tenant of a house and lot constructed a small scaffolding eight or ten feet high. From this structure he was boring a well, using an augur with an iron pipe attached that had an over-all length of 31 to 32 ft.

Across this lot the Gulf States Utilities Co., with the permission of the owner of the property, had strung a power line of three wires, 28½, 25, and 23½ ft, respectively, from the ground. In the well drilling operation this 30 ft of pipe and augur came in contact with these wires and the man was killed.

The Louisiana court held the company free of negligence, and said of these rules of the Federal Department of Commerce that they permit the employment of uninsulated wires but require a minimum vertical clearance above the ground of 15 ft where they cross over spaces on ways accessible to pedestrians only. Here there had been no violation of these safety requirements and the company, having fulfilled the legal duties imposed upon it, was not negligent.

A somewhat similar accident occurred in Stockton, California, where the victim of the accident was working in the construction of an underground sewer. A high voltage power wire of the Pacific Gas and Electric Co. here paralleled the street about 26 ft above the ground.

Sections of concrete pipe from a nearby field were being transferred to the excavation by a crane with a 26-ft boom and attached by this workman to the chain from the crane boom. The boom came in contact with the overhead wire when the workman was holding the iron hook of the chain and the man was electrocuted.

No negligence, the court held, could be imputed here to the power company. For actionable negligence three elements must occur, (1) the legal duty to use due care, (2) a breach of that duty and (3) a lack of care that is the cause of the injury.

Lawsuits are always unpleasant matters and are to be avoided wherever possible. Because of their far flung nature with respect to the public domain, Electric Utility Companies are particularly prone to legal action on the part of individuals who come in contact with their lines. Circumstances vary, and it is never possible to know exactly who was, and who was not, responsible in a case of accident, nor is it possible to know just what decision a court might make. In this article, however, Mr. Gray presents a number of opinions handed down by various courts covering several different kinds of accidents, and these should be of interest to all individuals concerned in the design, construction, and operation of public utilities

This rule was supplemented by the court in this instance with the comment that legal duty does not mean that a power company maintaining high voltage lines must anticipate every possible accident that may occur but it does mean that if it could be reasonably anticipated that the accident would occur, then the company would be liable if it failed to use proper care in warning of high voltage wires.

In an action against the Duquesne Light Co. in Pennsylvania involving almost identical circumstances the court refused to hold that company liable for negligence in injuries occasioned by an increased danger from changed conditions of which the power company had no notice or knowledge.

Across the property of the American Bridge Co. had been strung overhead high tension wires. These wires were uninsulated but carried by poles 36 ft above the ground.

An employee was moving a pile of telephone poles, aided by a crane with a 65 ft boom. At the time of the accident this employee was holding a hook and metal sling at the end of the drop cable, dragging it away from the crane to attach to one of the poles. The end of the boom was above the wires and through the dragging of the drop cable, was pulled against the wires and the workman killed.

Of the part of the power company in this tragedy the court said, holding it free of responsibility for the occurrence, "The light company's duty was to install the high tension lines in a safe and proper manner and thenceforth maintain them in a safe condition upon reasonable inspection from time to time."

In Arkansas, on the other hand, a power company was held responsible for the death of a young woman by failing to adhere to the duty laid down by this rule of law. A tension wire had sagged to within 5 ft of the ground from a storm and the weight of a tree branch blown across the wire. The danger of the situation was patent and within the knowledge of the power company. Nevertheless the company neglected for a considerable period of time to repair the line. This woman came in contact with the wire and was killed.

"The obligation of repairing defects does not mean merely that the company is required to remedy such defective conditions as are brought to its actual knowledge," said the court. "The company is required to use active diligence to discover defects in a system."

In the case involving the Duquesne Light Co. in Pennsylvania, on the other hand, the conditions had become dangerous through no agency of which the light company had notice or knowledge.

But where that which has been safe becomes harmful only by reason of the action of a third party which the power company was not required to anticipate and a sufficient time had not elapsed or the situation was not so reasonably apparent as to charge it with constructive notice of this particular kind of dangerous condition, actual notice is required, for a power company is not obliged to seek out defects of this character or to assume they may arise.

References

Croxton v. Duke Power Co., 181 F.2d 306
Iowa-Illinois Gas & El. Co. v. Young, 179 F.2d 485
Welch v. Gulf States Utilities, 32 So. 2d 723
Lewis v. Pac. Gas & El. Co., 212 Pac. 2d 243
Reed v. Duquesne Light Co., 47 A. 2d 136
Brakensiek v. Nickles, 227 S.W. 2d 948
Greenwald v. Northern States Power Co., 32 N.W. 2d 320

Design Factors in the Modern Steam Generator

Modern boiler designs incorporate many features to provide for higher outputs, flexibility in the use of fuels, and protection of materials to lengthen the time between service outages. In this article, Mr. Swengel discusses some of the methods used in boiler design for accomplishing these ends, and to raise the upper limits of pressure, temperature and firing rate without sacrificing dependability

By F. M. SWENGEL

Head, Mechanical Section, Stanley Engineering Company, Muscatine, Iowa

THE TREND in the design and construction of steam generating units is definitely pointed at the use of a wider range of fuels, a higher output per unit of volume, and operation at higher pressures and temperatures than were formerly in use. The aim is to meet these increases in duty cycle while still securing improvement in the dependability and availability of the boiler units and simultaneously securing lower maintenance costs on the equipment.

The materials with which the boiler designer works have undergone improvement in the last several years. Metallurgy has produced more closely controlled steels and alloys capable of application in temperatures higher than were considered sound practice a few years ago. Improved refractories and protection of refractories in the arrangement of the boilers and furnaces has resulted in virtual elimination of heavy refractory maintenance in the modern steam generating unit.

The designer of the modern boiler unit has available ferritic carbon steels suitable for continued application to temperatures up to approximately 850 F. The low chromium alloy steels may be applied for metal temperatures approaching 1100 while austenitic steels have been used for metal temperatures up to 1200 in continuous service and in many cases are being applied to operating temperature conditions approaching 1800 F. As a particular example of this latter high temperature service, attention is called to the blading and components of the modern gas turbine with particular reference to the aircraft type of jet engine.

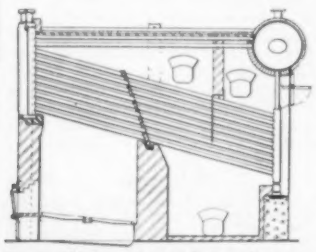


Fig. 1. Sectional header boiler which was fairly common not very many years ago, and using refractory furnace

Refractory metals include the conventional and superduty type of fire clays having softening temperatures from about 2600 F upward to perhaps 3200 F. For higher temperature applications a high-alumnia type of refractory may be used for temperatures up to 3350 F. For still higher temperature conditions the use of chrome ore extends the capabilities of refractories into the highest ranges of temperature that are normally encountered in the steam boiler furnace.

It is evident that the use of high alloy steels and the extremely high quality refractories would entail a considerable increase in cost over that encountered with carbon steels and common refractories. Consequently, the modern boiler utilizes these high alloy steels and the super quality refractories only where it is absolutely essential in order to secure reliability in service and to offset the extremely severe conditions prevailing at that particular location.

It should be pointed out that the flame temperatures theoretically attainable with any of the common hydrocarbon fuels are never realized in practice. This is due in part to the excess air that is normally necessary to secure complete combustion. It is further due to the fact that combustion is not instantaneous and since the combustion process is progressive and covers a travel in the furnace of the hydrogen and carbon particles, there is a substantial loss of heat due to radiation. Theoretical temperatures in the order of 4500 F may be secured; however, in actual practice, it is unusual to find temperatures much in excess of 3200 F in the actual flame. A possible exception to this is the combustion of natural gas with preheated air supply in which case the flame is extremely short and very high local temperatures may be secured.

Controlled Radiant Heat Absorption

Typical of the modern boiler design is the extensive and controlled use of radiant heat absorption in the furnace. The boiler designers of several years ago built the furnace entirely of refractories and all heat transfer was primarily accomplished by convection. Figure 1 illustrates a sectional header boiler which was a type fairly common in the smaller boiler plants of several years ago and even had rather extensive use in larger stations. The only radiant surface in the boiler was that formed by the lower tube bank immediately above the furnace. When attempts were made to greatly increase the amount of fuel burned within the furnace it became necessary to increase the furnace volume since there is a definite practical

limit on the heat release rate within a furnace. This, in turn, increased the distance from the grate or burner outlet to the tube bank and decreased the radiant effect by the square of the distance from the flame. The whole result of this trend was to increase the mean furnace temperatures to the point where ordinary refractories became the limiting design factor.

The natural trend was then to resort to water cooling of the furnace walls. This water cooling permitted radiant heat absorption at all points in the furnace and effected a continuous removal of heat from the combustion process, thereby establishing lower maximum temperature conditions within the furnace and at the same time shielding the refractories from the excessive heat resulting from the high firing rates. The modern trend has resulted in a continuous increase in the amount of radiant heat absorption in the furnace until we have reached the point in modern boilers, where a continuous metallic surface is present in the furnace. A typical wall detail for a small unit is shown in Figure 2 wherein flat fins are welded to the tubes and these fins abut with those of the neighboring tube to make a continuous metallic surface. For the larger units in which still more surface is required, the tangent tube type of construction is used in which the furnace is formed by water wall tubes each touching its neighbor. This forms a solid water screen between the furnace and the refractories and insulation.

Since the temperatures are highest in the furnace proper, it is obvious that the bulk of the heat transfer that is used to generate steam can and does occur in the furnace alone. In the ultimate example of this trend, the radiant type boiler has all steam generation performed in the furnace proper, no convection surface being used for this purpose.

Features of Water-cooled Furnaces

There are several aspects of the fully water cooled furnace which should be examined:

1. The effect of the method of firing
2. The rate of firing
3. The kind of fuel burned
4. The limitations imposed by the fuel characteristics.

If a solid fuel is burned on a bed, as is the case with any of the stoker fired units, the radiant effect is greatest immediately adjacent to the fuel bed and is greatly reduced in the upper portions of the furnace wall. This condition is particularly prevalent in the case of the underfeed or multiple retort type of stoker. The spreader stoker, on the other hand, burns a substantial portion of the fuel in suspension, and in consequence, the radiant effect is present much higher in the furnace and a considerably greater heat transfer occurs in the upper portion of the furnace. Examination of boilers designed for these various types of stoker firing will show that the chain grate, underfeed and multiple retort type of stokers frequently use fully water cooled sections on the lower part of the furnace wall only, the upper portions of the furnace being bare refractory. The same type of examination of recent spreader stoker installations will show that the average furnace is formed by water tubes ranging from the fin tube type shown in Fig. 2 down to a relatively open spacing with exposed refractory between the tubes.

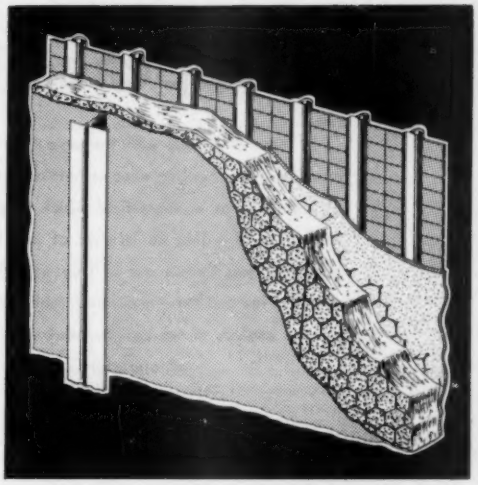


Fig. 2. Typical furnace wall section used in small boilers wherein flat metal fins are welded to the tubes to increase heat absorption

In the case of oil and gas fired boilers, a similar water wall construction is used because the condition is somewhat comparable to that of the spreader stoker. Particularly in the case of gas firing, where a very short flame travel is involved, the maximum radiant heat absorption is limited to the area immediately adjacent to the burners. With oil firing a somewhat longer and more luminous flame results which extends the radiant heating surface that is active. This accounts largely for the reason why higher gas temperatures entering the superheater are encountered with gas firing than is the case with puverized coal or oil.

Firing of coal in suspension as is performed in the conventional pulverized coal installation permits a long flame travel with a progressive heat release from the combustion process. For this reason, almost the entire water wall area can be made effective radiant heat transfer surface. If the flame is shortened or is directed away from a portion of the furnace, a corresponding reduction in the radiant heat transfer is accomplished. This feature is utilized by the Combustion Engineering Superheater Company in their tilting burner type of control. Similar differential firing of high and low burners is used by other manufacturers to accomplish the same end result.

A further factor influencing the use of radiant surface in the pulverized coal fired boiler is the effect of slag accumulations on the furnace wall. This, in effect, reduces the

(Continued on page 126)

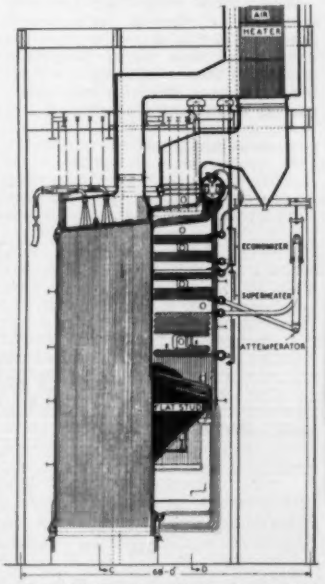


Fig. 3. The modern, high pressure, high temperature boiler in which nearly all of the steam is produced in the furnace water walls

It All Happened in Fifteen Seconds

Only those who deal with the operation of large electrical systems can appreciate how fast things happen when something tends to go wrong. The disturbance, described by Mr. Higgins in this article, which is reprinted here from *Electrical Engineering*,[1] all happened within an interval of just fifteen seconds. During that time, a large generator was thrown out of step with the large system to which it was connected, speeded up and then recovered synchronism with the system frequency. This clear, concise analysis of the entire disturbance from start to finish should be of interest to all operators of electric generating equipment

By D. D. HIGGINS
Superintendent of Generating Stations, Commonwealth Edison Co., Chicago, Ill.

THIS CASE of operating trouble is both interesting and instructive from a generating station point of view because the graphic record of the electric energy disturbance is complete. The description deals specifically with the in-step and out-of-step relationships of the generator rotor poles to the rotating magnetic poles produced by currents flowing in the stator windings during normal conditions and during the abnormal condition brought about by underexcitation.

While there is nothing unusual about the behavior of the turbine-generator in this case of trouble, as it coincided with known behavior, it is one of those rare cases in which the disturbance, resulting from subnormal excitation of a loaded generator, was recorded from start to finish as shown by the chart in Fig. 1.

A tanden compound turbine unit operating at about 90 per cent load, connected only to a 132-kv system, was the setup involved in the trouble. A switchboard operating error resulted in the generator field being excessively weakened, but not opened, during an intended normal regulating operation. This operation consumed only 5 to 8 seconds, after which the kilowatt load on the unit was observed to swing violently, the voltage dropped quite low, and the incandescent lights were observed to pulsate for a few seconds and then, by the strengthening of the field and the decrease of steam input to the turbine by governor action, the disturbance ceased and conditions became normal. The machine had broken step with the system and, while still connected to it, had dropped a large part of its load, accelerated, shut off some of the steam supply, decelerated, and resumed parallel operation, all in about 15 seconds.

[1] December 1950, p 1105.

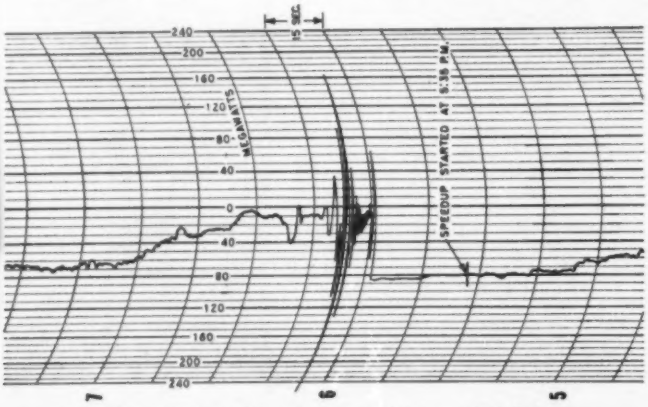


Fig. 1. Megawatt output of the a-c generator during period of disturbance
Editor's Note: Those not familiar with recording charts may be puzzled by the fact that this is obviously an hourly chart, marked in 15-minute intervals, yet the interval of the disturbance is labeled 15 seconds. The reason for this is the fact that recording charts of this kind are provided with a speed-up device which automatically speeds up the driving mechanism 60 times when some abnormal or subnormal condition arises. In this instance, the speed-up started, automatically, at 5:35 p.m.

To explain exactly what takes place in the parallel operation of generators, it is necessary to state precisely the particular condition that is to be described. Actually what is observed on switchboard instruments is a blending of the results of two principal and distinct influences; these are relative excitation and relative energy input to the generators.

It is necessary, therefore, to keep in mind the particular basic point under discussion as the machine performance under a definite condition is presented step by step. The case in mind here is the behavior of a loaded generator, operating in parallel with others, when its excitation is first decreased below normal and then re-established at its normal value. One way of presenting the case for analysis is to assume a simple bus setup that includes only essential elements. This hypothetical generating station has one bus and two generators, and the generators are assumed to be shut down and the bus, dead. The generators have two poles and the armatures have only one coil per phase (Figs. 2 and 3). The armature resistance may be neglected since it is comparatively small in large machines.

One generator is brought up to speed, excited, and connected to the bus. To establish a reference point it may be assumed that the center point on the north pole is under A-phase armature conductor at the instant No. 1 generator is put on the bus and before it is given any load, and the steam input to the

turbine is maintained to keep the unit at exactly synchronous speed. The dots and arrows of Fig. 3 show the instantaneous polarity of the generated voltage, that in A-phase being at a maximum for the instant shown. A current in phase with the generated voltage and flowing in the A-phase armature coil will produce a magnetic flux in a plane parallel with the axis of the coil and lagging the axis of the rotor flux by 90 deg as shown in Fig. 3. The relative position of the stator rotating field will be greater or less than 90 degrees depending upon the angle by which the current leads or lags the generated voltage. The generator then is given a very small load of unity power factor while the steam input is increased so that there is no momentary loss of speed. As the load is put on, there are two important things that occur:

1. A drop in voltage takes place within the armature winding because of its reactance, IX in Fig. 4. To maintain constant terminal voltage E_t, the field will have to be strengthened, thereby increasing the generated voltage E_g. It should be noted that the phase of the generated voltage now leads the phase of the terminal voltage by the angle δ.

2. The unity-power-factor load current (in phase with the terminal voltage) will produce magnetic flux as described previously, but it will lag the rotor flux by an angle greater than 90 deg. In other words, it can be said that the stator poles form in between the rotor poles, and the two sets of poles, rotor and stator, maintain that relationship under conditions of light load at unity power factor.

A second generator now is brought up to speed with voltage and frequency approximately correct for synchronizing. Before synchronizing the second generator, the conditions that exist at the terminals of the switch to be used must be examined. The incoming generator is assumed running at a slightly greater speed than the generator on the bus and the two voltage waves are plotted in Fig. 5A. The difference in voltage of the two waves, Fig. 5C, as measured by the voltmeter, is shown in Fig. 5B and can be called the resultant voltage. It is this resultant voltage that is impressed upon synchronizing lamps and synchroscopes. When the speed, and, therefore, the frequency of the incoming generator is adjusted so that the waves of Fig. 5A coincide exactly, and the voltage of the machine and bus are equal, the proper synchronizing point has been reached and the switch may be closed. At this time the resultant voltage is zero. From here on, the operation of the generator is controlled in two ways —by the amount of energy delivered to the drive shaft and by the strength of the rotor poles.

Any momentary slight change in the speed of either generator causes one generator to be ahead of the other, which causes a difference in the time-phase relation of the two instantaneous voltages. The resultant voltage now is impressed upon the series circuit consisting of the two armatures, the bus bars, and the connecting cables.

Because of the highly inductive nature of this circuit the current that flows, usually called synchronizing current, lags the resultant voltage by nearly 90 deg. The phase relationship of the circulating current to the load current in the fast generator will make the two currents additive and, in combination with the generated voltage of that generator, produces a true power load in addition to the load already on that generator, and this slows the generator down.

This load is merely a stiffening of the stator poles which imposes more opposition to the relative forward movement of the rotor poles. Similarly, the phase relation of this circulating current to the load current of the slow generator makes them subtractive, decreases the total current, which decreases the load on the slow generator, decreases the opposition to the forward relative movement of the rotor poles, and allows this rotor to advance.

Thus the action of the circulating current, produced when one of the generators attempts to pull out of step, sets up a reaction which slows down the fast machine and accelerates the slow machine, thereby tending to keep them in synchronism.

With two generators in parallel, carrying the same load and at the same power factor, it can be assumed that the generated voltage of each machine will lead the terminal voltage by a definite power angle. If the field current of one generator is increased now, the strengthened rotor field will tend to slow the generator down and the power angle will be reduced, as shown in Fig. 6. A change in power angle will result in the armature current becoming more lagging since the real power, as supplied by the prime mover, is unchanged. To maintain the bus voltage at a constant value, the excitation to the other machine must be reduced. The weakened rotor field of the second generator will allow it to advance slightly so that its power angle will increase. The effect of this shift is to make the armature current of the machine less lagging. Since regulation of the field current of a machine affects only the quadrature component of armature current, it allows the reactive power of the machine to be controlled. It is significant to note that the power angle, the angle beween generated voltage and terminal voltage, is increased when the field is weakened. The power angle is also dependent upon the power supplied the generator shaft by the prime mover.

Load or torque on a turbine is the effort required to push and pull the rotor poles from the position in which the rotating stator poles are trying to hold them. The pole polarities and position relationships tend to pull the south rotor poles away from the north stator poles and force them against the south

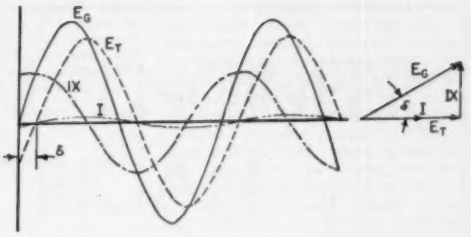


Fig. 4. Relation of generated voltage to terminal voltage of an a-c generator with a unity power factor load

E_g = generated voltage; E_t = terminal voltage; I = armature current; δ = power factor angle

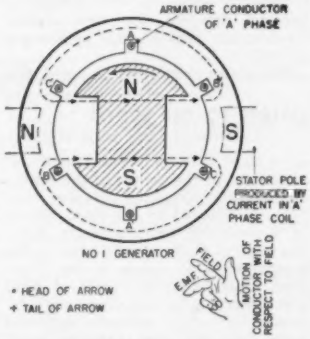


Fig. 3. Elementary diagram of a 2-pole, 3-phase a-c generator having one slot per pole and phase

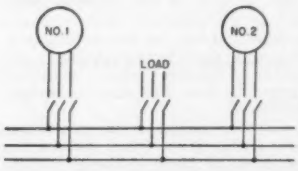


Fig. 2. Connections of an elementary generating station

stator poles when energy is applied to the generator shaft. The more energy supplied to the generator shaft, the greater is the angle of advance of the rotor with respect to its position at no load. As was pointed out previously, a reduction in field excitation also will increase the power angle; this has the same relative effect as increasing the amount of energy supplied the generator shaft. Therefore, both the governor control and the field excitation control produce an effect upon the rotor position relative to the stator poles. When these controls are set so that the south rotor poles are directly under the stator poles, a critical point has been reached and a further increase in rotor angle will result in the machine falling out of synchronism and it will slip poles.

Another way of visualizing this critical point is to note that the generated voltage will lead the terminal voltage by a power angle of 90 degrees. For this power angle, the synchronizing power is practically zero so that any slight disturbance will have a tendency to cause instability in the system.

The magnitude of the synchronizing power is dependent upon several factors, two of which are under the operator's control. These are the excitation of the machine and the power angle control achieved by the governor. The greater the excitation, the larger is the synchronizing power. However, a large power angle results in a smaller synchronizing power. It is evident, therefore, that operation of a machine at high load with a relatively weak field sets up a condition where the macine may more easily fall out of step than if operated at a lower load with a strong field.

In this particular case of trouble the machine was connected to the far end of a fairly long transmission line so that the power angle was

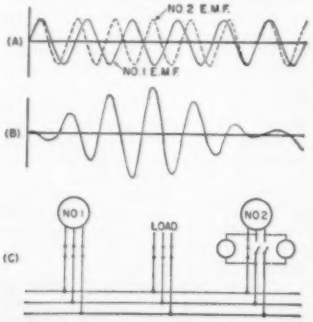
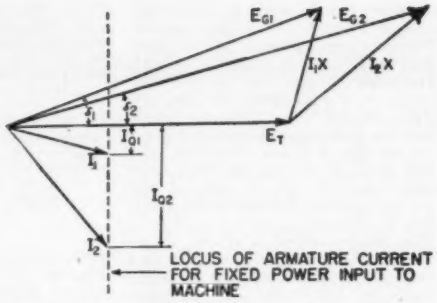


Fig. 5. (A) Voltage waves of two a-c generators before synchronizing. Generator No. 2 running faster than generator No. 1. (B) Resultant of two voltage waves shown in (A). (C) Connections of voltmeter or synchroscope upon which the resultant voltage in (B) will be impressed

Fig. 6. Change in power angle (δ) due to change in field excitation, power input from the turbine remaining constant



somewhat greater than it would have been had the generator been feeding the system directly. When the switchboard operator inadvertently weakened the field, the synchronizing power became so low that the generator fell out of step with the system. This generator was driven up to 64 cycles, and as the north rotor poles were driven past the north stator poles, resulting in minimum voltage, the incandescent lights were seen to pulsate at a frequency equal to the difference between the machine and system frequencies, that is, four cycles per second.

When the turbine accelerated, the speed-governing devices reduced the steam input to the turbine allowing it to decelerate. The switchboard operator, diagnosing the situation at this time, strengthened the field, which, with the reduced input of steam and deceleration of the unit, caused the synchronizing power to become great enough to restore the machine to synchronous operation, whereupon it assumed a steady load.

The whole disturbance lasted only 15 seconds. The megawatt chart of Fig. 1 shows the interchange of power between the generator and the large system to which it was connected.

LETTERS TO THE EDITOR

(Continued from page 67)

downward over a central shaft or courtyard in the center of the building. The rays from the movable mirror are reflected by the fixed mirror in a powerful beam straight down the central duct, down as far as the basement. This beam is the *main* from which narrow shafts of light are collected as required, and, by means of other mirrors, reflected from room to room through small openings at ceiling level. The main beam has an intensity of some 30,000 candle power on a bright day, sufficient to illuminate a large number of rooms.

This system is said to have passed the experimental stage and for the past six years it has been used in France, Belgium, Holland, and North Africa. The newspaper *Intransigeant*, in Paris, has been using sunlight to light up its offices and press rooms for several years. So, also, has the famous Havas news agency in Marseilles. Every floor of a large department store in the Hague, Holland, including the basement, is sunlighted by the Arthels system, as is also the central post office at Amsterdam. In several of the modern flats in France, equipped with the Arthel Heliostat, the rooms are lighted with diffused rays through glass panels in the ceilings while direct beams are focused at will on tables, chairs, etc.

The Arthel heliostat comes in several sizes, from huge units weighing six tons to light up whole blocks of offices to small units for small stores and private homes. The smallest are quite simple and motorless and weigh only a few pounds.

Recently, the equipment has been brought to a high state of perfection. It now has an automatic mirror-wiper which prevents the upturned mirror from becoming grimy. An arm, operated by an electric motor, sponges and polishes the mirror once a day as it swings from west to east to catch the morning sun. The pilot-mirror thermostat controls the mirror motor causing it to move at the same rate as the sun. Because the sun moves very slowly, the pilot thermostat is so designed that the sun itself sets the mirror turning slowly every few minutes and then stops as soon as the mirror has caught up. This ingenious device consists of three sensitive thermometers placed around the edge of a small steel mirror set in a telescopic tube. As long as the sun is shining full on the master mirror, the solar image is reflected in the center of the steel mirror. When the sun moves forward its image falls on one of the thermometers and as the mercury rises it makes contact and sets the mirror in action. When the sun's image returns to the center of the steel mirror, the mercury falls and the electric contact is broken.

Another gadget is the correcting gear in the pivot which follows the sun in its 12 month variation in declination.

Brooklyn, N. Y. E. P. HERMAN

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

PUTTING STEAM TURBINES INTO SERVICE

IN THE December issue, in this space, as many of you who read this may recall, we asked whether anybody was willing to try to write an article or a series of articles, describing exactly how steam turbines are installed and put into service.

This request was inspired, as pointed out in the December issue, by the series of articles by John C. Gore, on boiler installation and operation in 1946 and 1947.

Because our specifications for the turbine articles were rather rigid we did not expect very many to be interested in the request —it required not only experience but also a knack of expressing what went on in the minds of the installers. We felt that there might be a few who might like to tackle the job and would have been quite happy if one or two had responded.

We guessed wrong, however. Answers to our proposition began to come in as soon as the December issue had been mailed. The first few were interested, they said, and asked us to send them reprints of Mr. Gore's articles. We did, but in the meantime, other answers began to reach us and soon we ran out of our small stock of reprints of these articles. A promise is a promise, however, and since we had offered to send the reprints to those who were interested, we began to have photostat copies made of the articles.

Well, answers to the request are still coming in, and we are still sending out photostats. Naturally, we are most gratified by this enthusiastic response and feel that we can promise you a very interesting series of articles on the installation of steam turbines some time in the near future. In the meantime we have the job of examining and weighing the qualifications of the prospective authors and deciding which one is best equipped to write the articles.

CONTENTS

Sawdust—How to Burn the Stuff 92
By Olin L. Brage

Take Your Steam Samples in Saturated, Not in Superheated, Steam 93
By K. H. Mack

How to Insulate Large Vessels 94

Some Maintenance Jobs You Can Do With Cold Pressure Welding 95

Sulphur in Fuel Oils 96
By Paul F. Schmidt

Basic Power Plant Figuring 98
By William H. Engelman and Jay P. AuWerter

Automatic Control for Molding Machines 104
By Howard T. Bailey

Beryllium Discontinued in Fluorescent Lamp Manufacture 105
By Dr. W. Schweisheimer

Questions and Answers 108

He Wants Data on Simultaneous Firing of Coal and Gas

How Should Small Plant Store and Handle High-Moisture Coal?

How Should He Figure Steam Engine Stresses?

A Section of Power Engineering Devoted to
PLANT OPERATION AND MAINTENANCE
Technical Publishing Company
110 S. Dearborn St., Chicago 3, Ill.

SAWDUST — How to Burn the Stuff

Question No. 474 on the burning of sawdust stirred up a great deal of discussion, some of which has been published in recent issues. Among the answers to the question was this discussion from Mr. Brage. His comments are so good that we felt they should be published as a separate article and so we asked him to supply a few photographs, which he did. Here they are, together with his comments on burning sawdust

By **OLIN L. BRAGE**, Spokane, Washington

THERE HAS BEEN considerable interesting discussion recently in these pages concerning the burning of sawdust under power boilers. This is of particular interest to us, here in the Northwest, because we just burn lots of sawdust as well as other wood refuse. So, these comments relating to my own experience with this type of fuel may be of interest.

The refuse we burn is of various kinds. It may be Douglas fir, longleaf pine, juniper, or one of many other woods. This fuel is burned in sawmill and wood-working plants under power boilers but it is also burned in considerable amount in domestic stoves and furnaces and under the medium size boilers found in institutional plants, hospitals, schools and large public and private buildings.

The accompanying photographs showing the burning of sawdust were taken at Brownson's Lumber Company mill in the town of Oroville in the Okanogan country in Washington.

Let it be understood first of all that sawdust is not just sawdust. It is as different as the wood it is cut from. Even in its green state sawdust cut from fir trees, call it fir dust or fir sawdust, will burn rather well and cleanly. When green, spruce sawdust does not burn quite so well as fir sawdust, and pine sawdust not so well as spruce sawdust. Worst of all sawdusts to burn, in my experience, is that from hemlock. It is almost impossible to burn this stuff without drying it well. When thrown into a furnace burning other fuel, it will do more damage than good, when green.

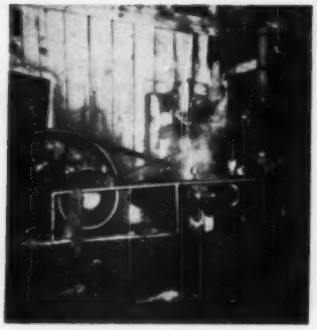


Fig. 4. One of open crankcase steam engines also runs on steam raised by sawdust burning

Your questioners[1] ought to keep in mind a scale of the various wood sawdusts, with fir at the top and hemlock at the bottom. Maybe some other men know a better sawdust than fir to burn, or a worse one than hemlock. Between them, I think, most other wood sawdusts can be classified according to their readiness to burn, as I have put them down here:

1. Fir.
2. Spruce.
3. Pine.
4. Hemlock.

A second way to describe the way sawdust burns is according to the degree of seasoning the wood has had before being cut up, or the sawdust has had afterward. If timber has been felled one winter, and not cut up till the next, the sawdust, even from hemlock, will burn much better.

Likewise, the sawdust from hardwood trees cut when the sap is down will burn a lot better than that from

[1] This refers to question 474 in the October 1950 issue of *Power Engineering* and some of the replies to this question in subsequent issues.

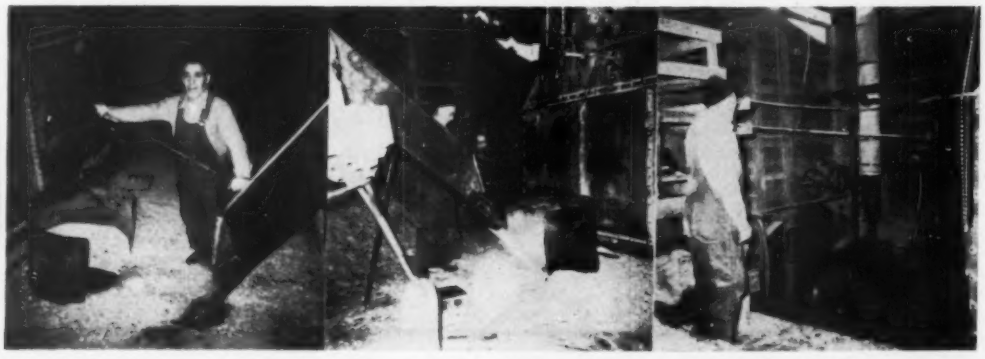
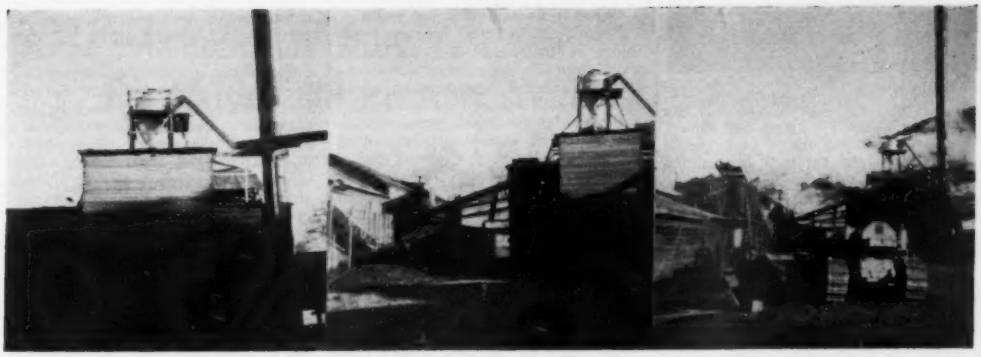


Fig. 1. Ed Manuel, power plant engineer for the Brownson Lumber Co. at Oroville, Washington, feeds sawdust into top of furnace from chute at left. Holes in furnace top are really firing eyes. Should mass of sawdust smother fire, Ed stirs it into flame with rod, or poker, he holds

Fig. 2. Here the chute has been raised to feed sawdust into the second eye. Curved piece of sheet steel keeps sawdust from splashing. Shovel is sometimes used to scrape scattered sawdust into the furnace. There is no danger of furnace flame rising, as current of air into the furnace is downward. A high amount of air is needed to burn sawdust. Also a large furnace volume

Fig. 3. The fireman has other duties. To keep from going down the steps into the pump pit, Ed has put up reacher rods to the steam valves of the pumps. Here he is starting up a pump



Figs. 5, 6 and 7. Funnel-shaped vessel on top of power plant contains sawdust fed to furnaces through chute shown in Figs. 1 and 2. The sawdust is blown into it through round duct leading into it at right. Box-like room between camera and power house contains wood refuse coarser than shavings but smaller than kindling. Kindling large enough to stop up firing eyes is picked out automatically and dumped by conveyor into a bin at left center, in Fig. 7 (Right)

trees cut when the sap is up, if both are burned at the time of cutting.

Sawdust from old pine trees does not burn as well and as cleanly as that from young trees of the same species, but will make a hotter fire. This is because of the greater amount of pitch in the older trees. This pitch causes the grains of sawdust to stick together into a mass when it gets hot in the furnace. In many furnaces the air and gas currents are strong enough to carry these burning masses out the top of the chimney before the combustion is complete.

In all too many instances sawdust is fired wet into boilers. This is just like firing wet peat from a bog, and is totally unfit for fuel. There is not enough fuel value in it to evaporate the water it contains. Water also causes flaming masses of sawdust to form, somewhat like pitch.

Dutch ovens help a lot in the burning of sawdust and other wood refuse. They give the extra space needed by this fuel for combustion. If there is not enough combustion space, or if the chimney is too small across, the air and gas velocity through the furnace and up the stack will be high, and will carry many of the lighter elements up the stack.

Sawdust just cannot be burned as rapidly as coal dust, and much more furnace volume is needed. When it is green or plain wet, the moisture in this sawdust is evaporated into steam. When its temperature is raised to 2000 degrees in the furnace, this steam imparts a greater velocity to the air and gas current up the stack, and causes it to carry more sawdust along.

In closing, the following comments on sawdust firing may prove helpful:
1. To burn right well, sawdust ought not get any wetter than it is when it comes from the sawblade. And if there is waste steam to be had, it is a good thing to use its heat to dry out the sawdust some.
2. Never pile sawdust where the rain or snow can fall on it. If it is worth anything as fuel, it is worth having a roof over it.
3. If the sawdust has got to be burned when damp, mixing it with needles, cones, leafy twigs and larger pieces of wood refuse helps a lot.
4. Don't try to mix sawdust in a furnace with other fuel. Sawdust has to have a lot of room to burn, and a lot of air. Keep the ashpit doors wide open and control the rate of burning with the damper and the thickness of the fuel bed.

Take Your Steam Samples in Saturated, Not in Superheated, Steam

If you sample both, you will find more total solids in saturated steam entering superheater than in superheated steam leaving it . . . Wha' happen! . . . Does the difference deposit inside the superheater tubes? . . . If not, where does it go? . . . The author explains very clearly what goes on . . . You don't get a representative superheated steam sample for determining solids, he says, with equipment available in power plants . . . Saturated steam sample more representative of actual steam purity . . . Here's why

By K. H. MACK

THE OTHER DAY I received a frantic telephone call from one of my friends who had just started up a new boiler in his plant and was in the process of testing it.

For his plant, the new boiler is an innovation. He calls it the high pressure boiler delivering steam to a new back-pressure turbine at 650 psig and 750 F temperature. The old boilers in the plant are 200 lb pressure boilers furnishing saturated steam to process.

The new high-pressure section of the plant was in service several weeks and was well beyond the usual shakedown run period. The new plant is equipped with a complete set of all essential instruments, including a conductivity recorder showing boiler water concentration and the grade of steam purity. The boiler manufacturer equipped the saturated steam space of the boiler, with three steam-sampling fittings equally spaced across the width of the boiler, but in addition, in compliance with the purchaser's specifications, steam sampling fittings were also installed in the superheater outlet.

The steam purity tests showed an average of 0.7 ppm solids entrainment in the saturated steam delivered by the boiler to the superheater, but the steam samples taken from the superheater outlet showed only 0.2 ppm in the steam leaving the superheater. This great difference created considerable consternation.

Samples were simultaneously

taken from the steam entering the superheater and leaving the superheater. Between those two points there appeared to be a loss of 0.5 ppm. of the solids carried into the superheater with the steam. They seemed to disappear while the steam was passing through the superheater.

Where else could these solids go but to be deposited in the superheater tubes?

It was carefully calculated that, with every 1,000,000 lb of steam delivered by the 100,000 lb-per-hr boiler, ½ lb of solids would be deposited within the superheater tubes, or about 1 lb of solids every 24-hr day. In one year this would be over 360 lb of material and, if it were laid down uniformly, over the entire inside area of the superheater tubes, there would be about 1/32 in. thick scale in the tubes. It was feared that the superheater would fail long before the year was over.

Stop Worrying—Why?

I suggested to my friend to stop worrying. I told him that it is useless to take samples of highly-superheated steam and to expect a correct indication of the solids in the steam. Superheated steam is a perfect gas. It is perfectly dry; and solids carried in this steam are of the consistency of bone dry dust, if they did not volatilize in their path from boiler drum to superheater outlet.

It stands to reason that it is not possible to catch these solids with the superheated steam sampling fitting in the same proportion as with the saturated steam sampler. Some of the boiler water solids carried into the superheater with the steam actually volatilize within the superheater and become a gas, which can easily pass by the steam sampling nozzle. Other solids have become so dry and are of such microscopic size that they, too, are carried past the steam sampling nozzle within the high velocity stream of superheated steam.

Incidentally, a part of the volatilized solids, such as silica, may condense and reappear as scale on turbine blades of the intermediate turbine stages.

Steam samples, to be nearly representative of actual steam purity, must be taken from the saturated end of the superheater. Most of the boiler water solids contained in the steam form the nuclei of minute droplets of water. The solid particles are wet and therefore sufficiently heavy to be caught with the steam-sample fitting. The density of saturated steam is, of course, much greater than that of superheated steam; therefore solids can be expected to be more uniformly distributed in saturated steam.

What to Do and What Not to Do

Regardless of the greatest care taken in steam sampling, the use of most complete equipment and carefully calibrated instruments, complete degasification of the condensed sample, and the most conscientious procedure of sampling, eliminating all possible error, the results can at best be expected as indicative of steam purity rather than to prove the actual contamination of the steam down to the second decimal point of a ppm.

Some of the contamination is in the form of volatiles, which may not completely condense with the steam and may disappear in the degasifier; but if steam sampling is carefully done and if the records show a total contamination of, for example, 0.7 ppm, it is reasonable to assume that the actual entrainment of all solids in the steam, both those which remain solids plus those which are volatilized, is well below 1 ppm but certainly not lower than the 0.7 ppm indicated.

Sampling superheated steam for the purpose of determining the entrainment of solids is useless, because it is not possible to obtain a representative sample with equipment at present available in steam power plants. Steam sample fittings should best be eliminated from superheater headers. They serve no practical purpose but may constitute potential trouble from leaks.

* * *

AN INGENIOUS method of pulverizing hard to grind things, such as plastics, pharmaceuticals, insecticides and foodstuffs has recently been announced. Liquid nitrogen in spray form rapidly cools the material to just the right degree of fragility just before it enters the pulverizing mill.

HOW TO INSULATE LARGE VESSELS

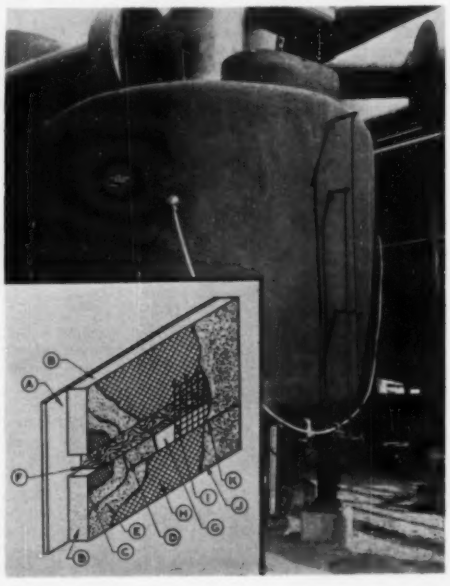
LARGE HEATED metal vessels—boilers, tanks, towers, finishing ovens and furnaces—don't always remain the same size. During initial firing or shutdown appreciable expansion or contraction (with temperature change) is an unavoidable physical fact.

Unless precautionary measures are taken the insulation on such large surfaces will crack and buckle. It is useful, therefore, to know how to design expansion joints which will enable the insulating layer to expand and contract with the metal surface.

On equipment operating above 600 F, horizontal expansion joints should be provided at 12 to 16-foot intervals. As shown in the diagram, these joints consist essentially of 1½ to 2 in. wide furrows of loose mineral wool, covered with protecting flaps of galvanized hardware cloth, between adjacent blanket edges.

The exact sequence of application of materials can be followed (from A to I) in the diagram, the width of the mastic and rosin paper strips (D and G) adjacent to the cleavage side of the furrow being 4 in.

The bottom edge of the hardware cloth flap (I) is left free to move up or down as the metal surface expands or contracts. Finally, after asphalt weatherproofing mastic (J) is trowelled over the whole job, a line of cleavage (K) is struck at the lower edge of each expansion flap with the point of a trowel.



These are the elements recommended for installing mineral wool expansion joints on heated vessels like the one pictured: A, heated surface; B, mineral wool blanket insulation; C, first ¼-in. layer of insulating cement; D, asphalt mastic strip; E, second ¼-in. layer of insulating cement; F, loose mineral wool fill; G, rosin-sized paper; H, 1-in. galvanized wire mesh; I, 12-in.-wide strip of 1-in. galvanized hardware cloth; J, asphalt mastic; K, line of cleavage

Some Maintenance Jobs You Can Do With Cold Pressure Welding

IN POWER PLANT maintenance and repair work, most of the equipment involved is "heavy stuff" and the methods of working on it are well known—or quickly learned—by competent power plant men. Once in a while, however, a job comes up that is a little out of the heavy equipment line—repairing an instrument or control device, joining electrical conductors and so on. It may involve work with thin nonferrous sheet metals, particularly aluminum or copper or involve some small part to be attached to a thin piece, or a thin sheet to be attached to a heavier piece. The new cold pressure welding method, known as the Koldweld process, may give you the answer to such problems.

This is the process by which soft metals can be joined by mechanical pressure, by use of simple hand tools with proper pressure points. No heat or electricity is required. These tools can be used without special training or employment of skilled labor. For tool details, write the editors.

The process was made available late in 1949 (see *Engineers' Preview*, January 1950 issue, page 7). It was developed in England by the General Electric Co. Ltd. (not associated with the General Electric Co. of the U. S.) and was brought to this country through the efforts of William Dubilier, now president of the Koldweld Corp.

As often happens with a new invention, the Koldweld process was expected by many to provide at once a solution to the most difficult and complex welding problems instead of being used in the more conventional applications. For example, the problem of welding very thin sheets of 75ST aluminum has never been solved by other welding methods. After much effort the Koldweld laboratories did succeed in welding the 75ST alloy, but not as yet with sufficient strength to make it acceptable.

As a result of the numerous inquiries, several new applications of the process were developed.

Trap Weld

Small kitchen utensil manufacturers wanted to weld screw studs to the sides of utensils for the attachment of knobs and handles. The required welded stud assembly was intended to replace the riveted assembly, which often becomes loose because of the heating and cooling cycles to which it is subjected when in use.

This led to the development of the trap weld, which proved to be superior to the older methods from the standpoint of strength and ease of application, as well as lower costs. The screw stud or a threaded insert is now, in effect, integral with the utensil. Details are shown in Fig. 1.

Thus, where it is necessary to make attachments to a body or a container usually made of nonferrous sheets, where moisture-proofing or pressure-tightness is required, Koldwelding offers a convenient way. It might prove very useful in repairs on instruments or small devices of one kind or another.

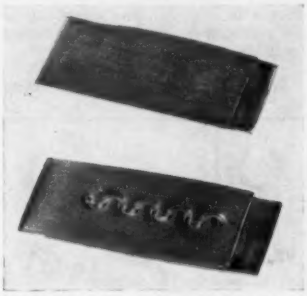


Fig. 2. Both sides of wave-welded joint

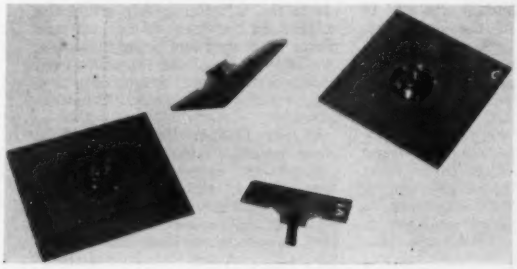


Fig. 1. Typical trap welds by cold pressure welding process. Base formed by same tool but with thread molded directly into aluminum base, shown at C. Threading obtained by molding base around screw, then removing screw. At 1A, cross-section of trap weld with screw stud. At top left, threaded insert molded into base metal

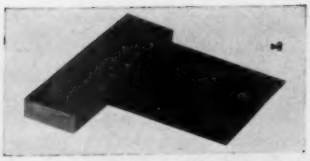


Fig. 3. Stagger weld for welding thin metal sheets to heavy bar stock

Fig. 4. Small silver contact welded to copper strip

Wave Weld

In many applications involving the welding of flat stock, the standard straight-line weld was sometimes found undesirable because of structural or esthetic considerations. To overcome these objections, the wave weld was developed, Fig. 2.

This wave weld is applied with the same ease as the regular straight-line weld. It is somewhat stronger as a result of the wave line intersecting the grain of the metal. The finished work has no tendency to bend or buckle along the weld line. Tools for making it consist of shaped element pressing against a flat plate.

Stagger Weld

It has always been difficult and sometimes impossible to weld comparatively thin metal sheets to heavy bar stock, such as encountered in the construction of truck bodies, tanks, railroad cards, metal shelving, shelters, and the like. In the stagger weld, Fig. 3, a number of dots or short staight-line welds are sightly staggered so that they lie along two or more parallel lines. The welds are formed with a special tool applied to the thin sheet side of the work.

Electrical Contacts

Silver electrical contacts, riveted or silver-soldered or brazed to copper or brass bars, are subjected in operation to extreme heat cycles because of arcing. With time, the bond between that contact and the bar is destroyed or loosened. A simple operation now permits permanently

Fig. 5. How simple hand tool welds thin non-ferrous metal sheets

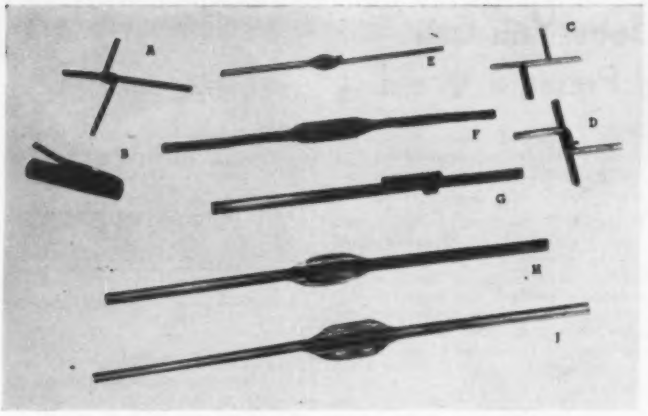


Fig. 6. Various welds on different combinations of electrical conductors
A—Two-conductor cross-weld, made in single operation. B—Weld of small copper wire to copper-clad steel rod. C—Aluminum or copper conductors, trimmed. D—Aluminum or copper conductors, untrimmed. Flashing can be left on, for it adds to strength. E—Weld of two conductors, copper or aluminum. The joint between two similar conductors has smaller resistance than conductor. F—Joint between two stranded copper conductors. G—Method of pigtailing a conductor to a rod with several turns of the conductor around the rod, to reduce mechanical strain on weld (compare with B). H—Weld of an aluminum conductor to a copper conductor of the same diameter. J—Two copper conductors welded together.

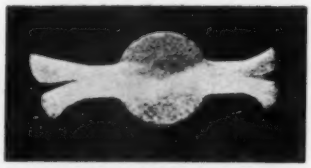


Fig. 7. Photomicrograph of aluminum and copper wire Koldwelded, to show how facing halves fuse and flow out into flaps at each side

Koldwelding small or large silver and other metal contacts for switches, circuit breakers, relays, and the like. See Fig. 4.

The process can also be used in welding heterogenous non-ferrous metals, so frequently required in the electrical industry. Commercial copper, pure electrolytic copper, beryllium copper, brass, silver, aluminum, lead, nickel, and their alloys, including Monel, may be welded to each other by cold pressure.

To weld extremely thin-nonferrous metal sheets (10 mils and less) a simple hand tool is used as shown in Fig. 5. This operation is not practical with heat-welding methods.

Wires and Conductors

With the cold pressure welding process, it now is possible to make various welds on different electrical conductors. See Fig. 6. These include a two-conductor cross-weld, welding a small copper wire to a copper-clad steel rod, welds of two conductors—of the same or dissimilar metals—ferrous and nonferrous, stranded conductors, pigtailing a conductor, and so on.

The Copperweld Steel Co., which supplies heavy copper-clad steel rods for grounding purposes, has developed, under a license from the Koldweld Corp., a very efficient method of connecting their conductors, making perfect contact as shown at B in Fig. 6, where a copper-clad steel rod has welded to it a small copper wire. Although the pressure was sufficient to distort and displace the steel conductors, a thin layer of copper was always present and the welding took place between the two copper surfaces. The weld proved to be mechanically stronger than the wire itself.

Sulphur In Fuel Oils

In this, the 11th installment of Mr. Schmidt's series on the characteristics of fuel oils, he discusses the effect of sulphur in fuel oils and methods of testing for sulphur. Maximum sulphur limits are specified and the corrosion due to sulphur is discussed in detail

By PAUL F. SCHMIDT
Allied Oil Company, Inc., Cleveland, Ohio

THE THIRD most important element present in an oil is sulphur, with carbon and hydrogen being the other two. Compared with carbon and hydrogen, the per cent of sulphur is very small, but even this small percentage can cause many headaches.

Free sulphur may be present, but it usually is in combination with carbon, hydrogen, or nitrogen, forming many different compounds. These numerous sulphur compounds are found in the crude oils as they come from the wells, as well as in many of the refined products.

Unfortunately, the greatest percentage of sulphur compounds are high boiling, and are therefore concentrated in the residual oils, and to a lesser degree in the distillates. Some refined products, such as gasoline, are treated to remove some of the sulphur, but fuel oils as No. 2, 5 and 6 are not treated. The reason for this is that the cost would be too high, and there is no practical way of doing it. As there are many types of sulphur compounds, there must be many different reactions to unite with sulphur and its compounds, so it is a rather difficult problem to solve economically. Also the sulphur compounds in the heavier petroleum fractions are not too reactive, chemically.

Method of Testing

There are various procedures of testing for sulphur and most of them are complex chemical methods, so only the Oxygen Bomb and Copper strip methods will be discussed, in general terms.

The Oxygen Bomb is a metallic cylinder, approximately 7 in. in height, 3½ in. in diameter, and walls ½ in. thick. A weighed quantity of oil is burned in the presence of oxygen, inside the bomb. The combustion products are removed from the bomb, and further processed by various chemicals. The final reaction being the addition of barium chloride to the solution, precipitating the sulphur in the form of barium sulphate. This chemical being insoluble, is filtered from the solution and weighed. From the weight obtained, the percentage of sulphur is determined.

In the Copper Strip method, a clean, polished strip of copper is immersed in the oil sample, and heated in a water bath for three hours at 122 F or three hours at 212 F. After the expiration of time, the strip is withdrawn from the oil sample and examined for any discolora-

tion and pitting. If there is, the test is positive, if not, it is negative. This test is generally used for light distillates, and only shows that there are some corrosive sulphur compounds present, but not how much.

Sulphur Contents of Different Grades

The following table will give a general picture of the various oils, and their varying sulphur contents.

No. 2 Oil	No. 4 Oil	No. 5 Oil	No. 6 Oil
0.16%	0.35%	0.68%	0.50%
0.26	0.38	0.75	0.89
0.30	0.44	0.82	1.06
0.42	0.49	1.02	1.25
			2.52

These results are from recently tested samples, and will give an idea of the sulphur range or spread in the different grades. The heavier grades, as a general rule, will have a higher sulphur content, than the lighter oils or distillates.

Maximum Sulphur Limits

The sulphur limits as listed in the Standard Fuel Oil Specifications are general in nature and quite high. The maximum for a No. 2 oil is 1.00 per cent, but no percentage is listed for No. 4, 5 and 6 oils. This is due to the fact, that different operations can utilize fuel oils with varying amounts, so most consumers, where the sulphur content is critical, will specify the maximum percentage allowed, and the supplier must conform to these limits set forth, in order to keep from trouble.

Corrosion Due to Sulphur

One of the biggest troubles due to sulphur is corrosion, but it will be well to remember that not all sulphur compounds found in fuel oils are corrosive. A high sulphur oil may not be as corrosive as a low sulphur oil. The reason for this is, that it is not always the amount of sulphur present, but the type. Some sulphur compounds are corrosive, while others are unreactive and will cause no trouble, even if present in large quantities.

With industrial installations there is generally little corrosion to pump and mechanical parts, due to sulphur. Where the combustion products are encountered, such as sulphur dioxide and sulphur trioxide, which are formed during the combustion, corrosion does occur. The corrosiveness of sulphur compounds found in soot is increased with the presence of moisture, which unfortunately is always present.

Many manufactured articles are affected by combustion products. When sulphur is burned, it forms sulphur dioxide, and is further oxidized by oxygen and moisture, to form more corrosive, sulphurous and sulphuric acid. This factor is quite important in such operations as heat treating, and in forging furnaces, where either the sulphur gases are absorbed by the metals, or the acids react with the metals. During the smelting of certain types of alloys, this reaction must be carefully watched.

In the glass and ceramic industries, low sulphur is a requisite, usually requiring a maximum of 0.25 per cent sulphur. A high sulphur material causes discoloration and pitting of the products. This is due mainly to the adsorption of the sulphur gases on the surface of the manufactured articles. Sometimes, industrial fuel oils do not have low enough sulphur content, so a No. 1 distillate must be used. This is a domestic fuel, with a sulphur range from 0.08 per cent to 0.20 per cent.

Sulphur Limits For Steel Mills

The greatest users of fuel oil residuals are the steel mills for their open hearths. Unfortunately, they require a low sulphur oil, with a maximum ranging from 0.75 per cent to 1.00 per cent. As the molten metal has an affinity for sulphur gases, it absorbs some of it, causing the metal to become brittle.

In such operations as under boilers, or where the products manufactured do not react with combustion gases, the sulphur content is not too important. Continued burning of high sulphur oils will cause excessive corrosion of smoke stacks.

The combustion of sulphur will produce less heat than the burning of carbon and hydrogen. Therefore, the more sulphur present in an oil, the less Btu value it will have. When a pound of sulphur is burned, 4000 Btu are liberated, as compared with 14,600 for carbon and 62,000 for hydrogen.

It is difficult to say exactly where the line exists in distinguishing low from high sulphur oils. Generally speaking, an oil of 1 per cent or less is called low, while above 1 per cent it is called a high sulphur oil. A high sulphur oil can sometimes be easily detected by the "rotten egg" smell present.

As with many other properties of an oil, the sulphur content can be lowered by blending with an oil of lesser content. As the sulphur maximums are usually for the heavy oils, blending to decrease the percentage of sulphur will be between two or more residual oils. This is necessary to keep the cost down on the blended oil, as well as to prevent the viscosity from decreasing, as would happen if a light oil, such as a No. 2 distillate was used to blend.

"I don't know about that new man, Chief—He keeps saying, Tch, Tch! What won't they think of next!"

Basic Power Plant FIGURING

A Review for Old-Timers — A Must for Young-Timers

By **WILLIAM H. ENGELMAN**
Mechanical Engineer
Department of Water and Light
City of Cleveland, Ohio

and

JAY P. AuWERTER
President
The C. E. Squires Co.
Cleveland, Ohio

All re-publication rights reserved by the authors.

How to Calculate Condensate in Order to Trap It Correctly

CONDENSATE is always a product of steam no matter how the power of the steam is utilized. It is, therefore, a factor of utmost importance, although it is all too often treated lightly, with resultant problems and lost efficiency. When condensate is handled properly, however, the full power and usefulness of the steam are obtained and the pent-up value in the condensate itself is reclaimed. This article explains the simple basic methods of figuring condensate load. A separate future article will describe the correct methods of trapping the condensate once the load is known.

Condensate forms wherever sufficient heat of evaporation is removed from steam.

You remember that after you have heated water to the boiling point, to turn it into steam, you have to add the heat (enthalpy) of evaporation. At atmospheric pressure this is 970.3 Btu per lb; at 100 psig or 115 psia it is 880.6 Btu per lb and so on for various pressures. All these values are given for every pressure in the Steam Tables (Thermodynamic Properties of Steam by Keenan and Keyes, published by John Wiley & Sons, Inc.).

Complete explanation of how water is turned into steam, what is meant by heat of the liquid, heat of evaporation, total heat or enthalpy of steam and the relations of all these to pressure and temperature, was given in the Basic Power Plant Fig-

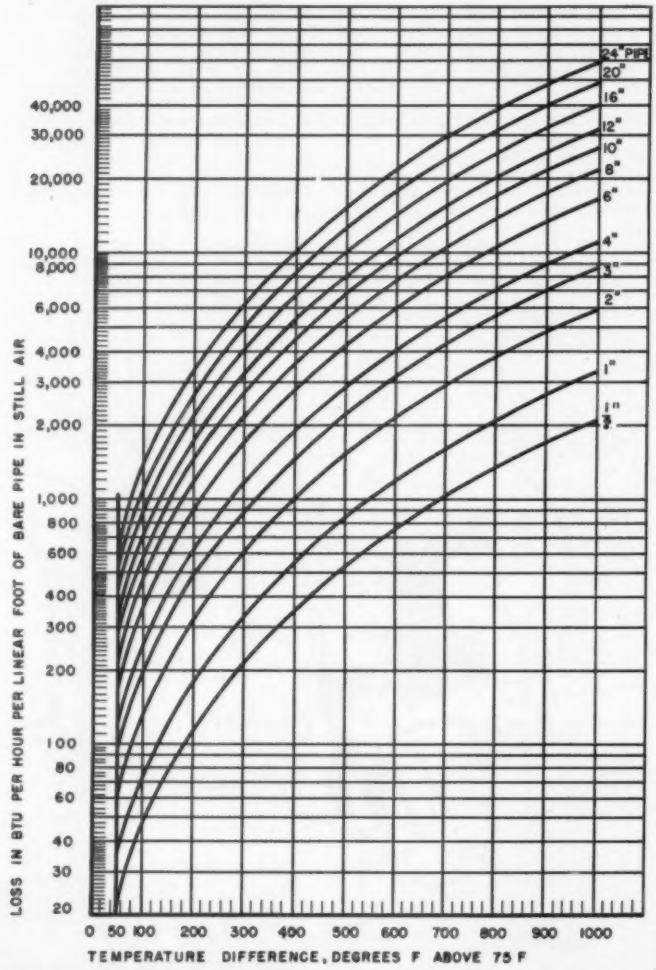


Fig. 1. Heat loss from bare surface of Schedule 40 (standard) pipe in Btu per hr per linear foot at various temperature differences

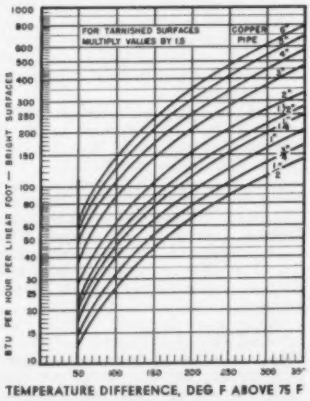

FOR TARNISHED SURFACES MULTIPLY VALUES BY 1.5
COPPER PIPE
BTU PER HOUR PER LINEAR FOOT — BRIGHT SURFACES
TEMPERATURE DIFFERENCE, DEG F ABOVE 75 F

Fig. 2. Heat losses from horizontal bare copper pipe, in still air, with bright surface, in Btu per hr per linear foot at various temperature differences

Table I. · Dimension data for standard pipe, Schedule 40, used in calculating amount of condensate in pounds per hour and in gallons per minute

Nom. Pipe Size In.	Outs. Diam. In. (O.D.)	Inside Diam. In. (I.D.)	Sq. Ft. Outside Surface per Ft.	Lin. Ft. per sq. ft. Outside Surface	GPM 1 ft/sec. Velocity	Lb. Water per Hour 1 ft/sec. Velocity	Inside Dia. $D^{2.5}$
	1	2	3	4	5	6	7
1/8	0.405	0.269	0.106	9.431	0.1771	88.65	0.0375
1/4	0.540	0.364	0.141	7.073	0.3243	162.33	0.0800
3/8	0.675	0.493	0.177	5.658	0.5950	297.79	0.1707
1/2	0.840	0.622	0.220	4.547	0.9471	474.02	0.3051
3/4	1.050	0.824	0.275	3.637	1.6621	831.90	0.6163
1	1.315	1.049	0.344	2.904	2.6938	1348.23	1.1270
1 1/4	1.660	1.380	0.435	2.301	4.6620	2333.3	2.2372
1 1/2	1.900	1.610	0.498	2.010	6.3454	3175.9	3.2890
2	2.375	2.067	0.622	1.608	10.4590	5234.7	6.1426
2 1/2	2.875	2.469	0.753	1.328	14.9230	7469.0	9.5786
3	3.500	3.068	0.917	1.091	23.0421	11533.0	16.4871
3 1/2	4.000	3.548	1.047	0.954	30.8161	15423.0	23.7112
4	4.500	4.026	1.178	0.848	39.68	19,859	32.52
5	5.563	5.047	1.456	0.686	62.36	31,209	57.23
6	6.625	6.065	1.734	0.576	90.05	45,070	90.59
8	8.625	7.981	2.258	0.443	155.93	78,042	180.00
10	10.75	10.020	2.817	0.355	245.78	123,013	317.81
12	12.75	11.938	3.340	0.299	348.88	174,614	492.41
14	14.00	13.126	3.665	0.273	421.77	211,096	624.21
16	16.00	15.000	4.189	0.239	550.80	275,675	871.42
18	18.00	16.876	4.712	0.212	697.19	348,942	1170.00
20	20.00	18.814	5.236	0.191	866.51	433,687	1535.30
24	24.00	22.626	6.283	0.159	1253.22	627,235	2435.10

A. Pipe up to 12 in. diameter inclusive is designated by its nominal inside diameter, I.D.; 14 in. and larger by its outside diameter, O.D.
B. Value in square feet of outside surface per linear foot is also square feet of heating surface.
C. Linear feet per square foot of outside surface, thus, 1.608 linear feet of 2-in. pipe equals 1 sq ft.
D. Discharge in gpm at a velocity of 1 ft per sec; for any other velocity multiply value in table; thus, velocity at 5 ft per sec in a 2-in. pipe is 5 × 10.459 or 52.3 gpm discharge.
E. Discharge in pounds of water per hour at a velocity of 1 ft per sec is based on 62.4 lb per cu ft at 52 F.
Flow in 2-in. pipe at 5 ft per sec is 5 × 5234.7 or 26,174 lb per hr.
F. Values of inside pipe diameters to the 2.5 power are the direct ratios of their discharge capacities. DO NOT use area only for comparing capacities; it is misleading and wrong. Example—
How many 2-in. pipes are equal to the discharge of a 5-in. pipe?
From Table: $5.047^{2.5}$ is 57.23; $2.067^{2.5}$ is 6.1426
and 57.23 ÷ 6.1326 is 9.3 — 2-in. pipes equal one 5-in. in flow.
But 20.006 ÷ 3.356 is 6.0 — 2-in. pipes equal one 5-in. in area.

Table II. Flow of steam in pipes, in cubic feet per minute

Sched. 40 Pipe, In.	Area Sq. Ft.	Velocity of Steam in Feet per Minute							
		3,000	4,000	5,000	6,000	7,000	8,000	9,000	10,000
1	0.0060	18.0	24.0	30.0	36.0	42.0			
1 1/4	0.0104	31.2	41.6	52.0	62.4	72.8			
1 1/2	0.0141	42.4	56.6	70.7	85.0	99.0	113		
2	0.0233	70.0	93.0	117	140	163	186	210	
2 1/2	0.0333	100	133	166	200	233	266	300	333
3	0.0513	154	205	256	308	360	410	462	513
3 1/2	0.0687	206	275	344	412	481	550	618	687
4	0.0884	265	354	442	530	619	707	796	884
5	0.1390	417	556	695	834	973	1,112	1,251	1,390
6	0.2006	602	802	1,003	1,204	1,404	1,605	1,805	2,006
8	0.3474	1,042	1,390	1,737	2,084	2,432	2,780	3,127	3,474
10	0.5476	1,642	2,190	2,738	3,285	3,833	4,380	4,928	5,475
12	0.7773	2,332	3,110	3,886	4,664	5,441	6,218	6,996	7,773
14	0.9397	2,819	3,759	4,700	5,640	6,580	7,520	8,460	9,397
16	1.2272	3,682	4,909	6,136	7,363	8,590	9,818	11,045	12,272
18	1.5533	4,660	6,213	7,766	9,320	10,872	12,425	14,000	15,533
20	1.9306	5,792	7,722	9,653	11,584	13,514	15,445	17,375	19,306

Note: In ordinary installations it is customary to allow maximum velocities of 1,000 to 1,200 ft per min per inch of pipe diameter. A good rule is:
Maximum velocity is 1,000 ft per min per inch of pipe diameter for 10 in. and under.
Maximum velocity is 1,200 ft per min per inch of pipe diameter for 12 in. and over.
In large steam mains with high pressure, velocities up to 24,000 fpm are used.
Velocity of saturated heating steam, up to 15 psig, is 4,000 to 6,000 fpm.
Velocity of saturated heating steam, 15 to 100 psig, is 5,000-10,000 fpm.
Lower velocities should be used for small pipes and upper limits should be used for larger pipes.

FACTORS TO KEEP IN MIND IN CONDENSATE CALCULATIONS

1. Always use heat of evaporation of steam corresponding to the absolute pressure. (Labeled Enthalpy of Evaporation, in the Steam Tables) in calculating Btu per pound of condensate.
2. For the majority of cases, temperature around pipes, process equipment and the like should be assumed to be 75 F. This is often called the ambient temperature.
3. Insulation can be obtained having efficiency factors of 75 to 95 per cent. Unless exact factor is known, use 75 per cent.
4. Use heating areas in *square feet* and linear dimensions in *feet* where these values are required.
5. Most frequently used constants:
   (a) 1 boiler horsepower = 33,475 Btu per hr
   (b) At 70 F (room temperature)
   1 cu ft water = 62.3 lb
   1 gal water = 8.33 lb
   (c) At 212 F (boiling point of water at atmospheric pressure)
   1 cu ft water = 59.83 lb
   1 gal water = 8.00 lb
   (d) Gage pressure, psig + 15 = absolute pressure, psia

uring articles in the March, April and May 1949 issues.

Now if you have dry saturated steam in a pipe or container, it is all steam, containing no water, and its total heat is heat of liquid plus heat of evaporation. If in some manner you take heat out of that steam, cool it or "condense" it, as we say, you first take out the heat of evaporation. When you have cooled all the steam enough to take out all the heat of evaporation, it has all condensed back into water at the saturation temperature corresponding to the pressure. This water is called condensate. You have removed the heat of evaporation and either wasted it or transferred it to some other substance for a useful purpose.

In a great many cases, you have to remove this condensate continuously or intermittently from the pipe or container in order to permit more steam to flow in and give up its heat of evaporation. For example, three types of installations in which condensate must be drained off are: 1—pipe lines; 2—processing equipment; 3—submerged coil heating.

One of the most common methods of removing condensate in such cases is by steam traps. You must first find out how much is formed in a given case so you can figure the size of trap to get it out of the pipe, container or heater. Here's how you do it. **Examples on page 100.**

I — How to Calculate Condensation in Bare and Insulated Pipe Lines

Pipe lines include headers, branch lines, connecting lines, feeders, risers, together with the fittings. To determine the amount of condensate, you must know all of the data concerning the pipe itself (dimensions, material, etc.), the type and number of fittings used, as well as the physi-

(Text continued on page 102)

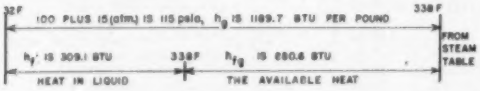
Example 1. Figuring Condensate in Pipe Lines with Fittings.

An 8-in Sched. 40 pipe, 100 ft long, carries dry saturated steam at 100 psig. The fittings consist of 2 flanged couplings, 2 standard 90-deg elbows, 1 standard tee, and 1 standard cross. The surrounding air temperature is 75 F. The pipe is used continuously throughout the whole year. Give detailed calculations on the following items:

a. Equivalent linear feet of pipe due to the fittings.
b. Heat losses in Btu per hour from BARE pipe.
c. Heat losses in Btu per year from BARE pipe.
d. Pounds of steam condensed per hour that must be trapped.
e. Money wasted per year because of heat loss, when using coal with 12,500 Btu per lb, boiler efficiency of 68 per cent, and the coal at $6.50 per ton.

Solution:

Linear feet of pipe	100.0 ft	
2 flanged couplings at 1.2 each	2.4 ft	see Fig. 3
2 stand. 90 deg ells. at 3.4 each	6.8 ft	see Fig. 3
1 standard tee	4.7 ft	see Fig. 3
1 standard cross	6.6 ft	see Fig. 3
a. Total linear feet	120.5 ft	


32 F
100 PLUS 15 (atm) IS 115 psia, h_g IS 1189.7 BTU PER POUND
338 F
FROM STEAM TABLE
h_f IS 309.1 BTU
338 F
h_{fg} IS 880.6 BTU
HEAT IN LIQUID
THE AVAILABLE HEAT

The temperature difference is 338 minus 75 or 263 deg.
From Fig. 1, the loss is 1,800 Btu per hour per linear foot of pipe.
b. 1,800 × 120.5 is 216,900 Btu per hour heat loss.
c. 216,900 × 24 × 365 is 1,900,044,000 Btu loss per year.
The loss is obtained by condensing the steam not by cooling, hence

d. 216,900 ÷ 880.6 is 246.3 lb of condensate per hour.

e. $\frac{216{,}900 \times 24 \times 365 \times 6.5}{0.68 \times 12{,}500 \times 2{,}000} = \$726.50$ waste on fuel alone per year

Note P. WHEN EXPOSED TO WIND:—If this 8-in. bare pipe is exposed to a wind velocity of 20 miles per hour, then from Fig. 4 the correction factor of 2.75 must be used and the losses will increase to:
216,900 × 2.75 × 596,475 Btu per hour.
246.3 × 2.75 or 667 lb of condensate per hour.
726.50 × 2.75 or $1,998 waste on fuel alone per year.

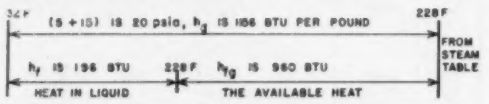
Note Q. WHEN PIPE IS INSULATED:—If the pipe is insulated with 85% magnesia pipe covering 2 in. thick, with an efficiency of 90%, the losses would reduce to:
216,900 (1.0 —0.9) = 21,690 Btu per hour.
246.3 (1.0 —0.9) = 24.63 lb of condensate per hour.
726.50 (1.0 —0.9) = $72.65 waste on fuel alone per year.

Example 2. Figuring Condensate for Typical Process Installation.

A platen made of ⅝-in. steel plate has an area of 4 sq ft. Dry saturated steam at 5 psig is on one side to heat water on the other side from an initial temperature of 80 F to a final of 180 F. The water is not agitated; the requirements are 2,000 lb per hr. Calculate:

a. The Btu required per hour.
b. The pounds of condensate per hour to be trapped.
c. The maximum Btu capacity of the platen.

Solution:



The available heat is that of the steam condensed; not the cooling of the condensate below 228 F, since all the steam must be condensed before the water temperature will drop below that of evaporation.

a. Heat required: 2,000 (180 — 80) = 200,000 Btu per hr.

b. Steam required (which is condensate load): 200,000 ÷ 960 — 208.3 lb per hr.

c. Conductivity of mild steel is 460 Btu per in. per hr per sq ft per deg F (4 × 460) ÷ 0.625 = 2,944 Btu per deg F
Log Mean Temperature Difference is 88.75 deg.
and 2,944 × 88.75 is 261,280 Btu per hr, maximum capacity of platen.

Note R. If the platen is made of some metal other than steel, the thermal conductivity must be taken into account. For example: copper has a thermal conductivity of 2,680, against that of steel at 460 Btu per in. per hr per sq ft per deg F.

Note S. If a substance other than water is to be heated, the specific heat in relation to water must be considered. If the substance heated is agitated, the transfer of heat is affected considerably and any calculation should take note of this condition. In such a case, the condensate would increase as well as the amount of substance heated.

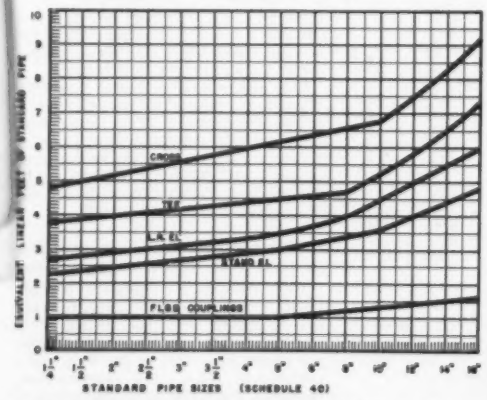


Fig. 3. Radiating area of 150 psi standard flanged fittings with companion flanges, expressed in linear feet of same size pipe

Example 3. Figuring Condensate with Submerged Coil Heating.

A 2,000-gal capacity heater has to supply 1,000 gal of water every 30 min at a temperature of 180 F. The inlet temperature of the water is 50 F. Allow 25 per cent heat loss due to radiation.

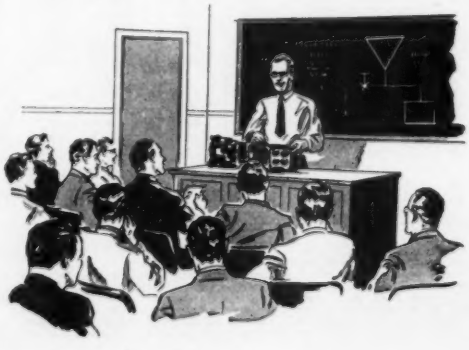
Calculate: a. The Btu required per hour including radiation.
b. The equivalent boiler horsepower (33,475 Btu per hr).
c. The square feet of heating surface required.
d. The linear feet of 1-in standard pipe required.
e. The pounds of steam condensed per hour when supplied at 5 psig. (Dry sat. steam at 100% quality.)

Solution:

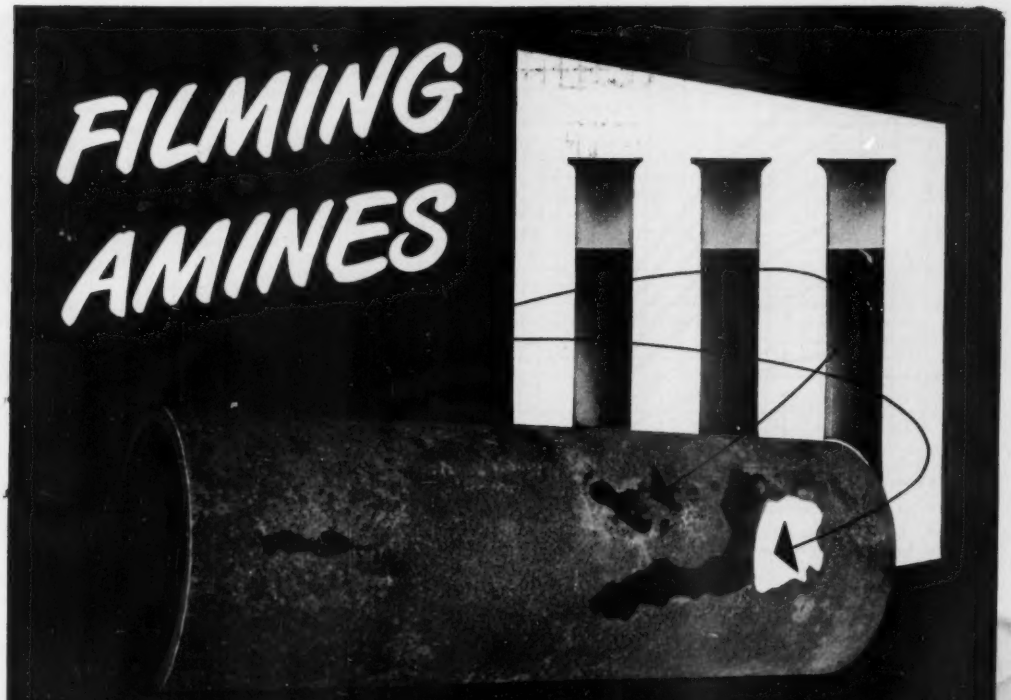
a. 2,000 × 8.33 × (180 — 50) × 1.25 (which is 100% + 25% heat loss) = 2,707,250 Btu per hour.
b. 2,707,250 ÷ 33,475 = 81 blr hp.
c. Assuming that 0.30 sq ft of heating surface equals 1 boiler hp, then 81 × 0.30 = 24.3 sq ft.
d. A 1-in. st'd pipe has an area of 0.348 sq ft per linear foot; then 24.3 ÷ 0.348 = 70 linear feet of pipe.
e. The available heat per pound of steam is 960 Btu, see Example 2.

Then 2,707,250 ÷ 960 — 2,820 lb of condensate.

Note:—Warm-up load is determined from a. above by substituting for (180 — 50) the amount of (247 — 50). The 247 F is the temperature of steam at 5 psi. The sizing of the trap for this condition will be discussed in another article.



FILMING AMINES



Prevent Return Line Corrosion

CORROSION of steam and condensate return lines is a serious problem to most industrial plants. Such corrosion is caused by the presence of carbon dioxide and oxygen. Up to now, it has been the usual practice to neutralize the carbon dioxide. However, the high cost of this neutralization method has limited its application. And, no protection against oxygen corrosion is assured.

Betz Laboratories have developed a new advanced process for the prevention of return line corrosion employing *octadecylamine.* This material *does not* neutralize the carbon dioxide. Instead, the amine is adsorbed on the metal surface in a monomolecular non-wettable film which acts as a barrier between the metal and the condensate, protecting against both oxygen and carbon dioxide attack. The monomolecular film does not increase in thickness with continued treatment.

Results? As high as 99 per cent reduction in corrosion rate has been achieved. Maintenance and replacement costs on return line systems have been reduced to negligible amounts.

Let a Betz Field Engineer show how you can cut costs in your plant with the use of filming amines. Write today! There's no obligation of course. W. H. & L. D. BETZ, Gillingham and Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories, Limited, Montreal 1.

Send for Betz Technical Paper #121, "How Filming Amines Prevent Steam and Return Line Corrosion."

[9]U. S. PATENT 2,460,259
CANADIAN PATENT 461,238

BETZ

BOILER WATER CONDITIONING • COOLING WATER CONDITIONING • INDUSTRIAL WASTE TREATMENT

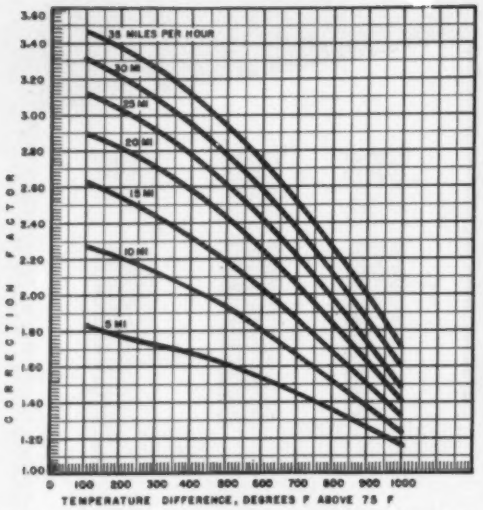


Fig. 4. Curves of correction factors for various wind velocities against bare pipe, for various temperature differences above 75 F (in still air)

Table III. Gage pressure, volume of steam in cubic feet per pound, and reciprocal of volume (pounds per cubic foot)

Pressure psig	Volume cu ft per lb	Reciprocal 1/volume	Pressure psig.	Volume cu ft per lb	Reciprocal 1/volume
0	26.80	0.03731	100	3.88	0.2577
2	23.40	0.04273	110	3.59	0.2785
4	21.10	0.04739	120	3.33	0.3003
6	19.20	0.05208	130	3.11	0.3215
8	17.63	0.05672	140	2.92	0.3423
10	16.30	0.06135	150	2.75	0.3634
15	13.75	0.07273	160	2.60	0.3847
20	11.90	0.08403	170	2.47	0.4055
25	10.50	0.09524	180	2.34	0.4266
30	9.40	0.10640	190	2.24	0.4474
40	7.80	0.1282	200	2.13	0.4686
50	6.70	0.1493	225	1.920	0.5214
60	5.82	0.1718	250	1.742	0.5741
70	5.20	0.1923	275	1.595	0.6270
80	4.65	0.2151	300	1.470	0.6803
90	4.25	0.2353	350	1.267	0.7893

Example:—How many pounds of steam per minute will an 8-in. pipe deliver at 30 psig and a velocity of 8,000 ft per min?
2,780 (from Table II) × 0.1064 = 295.8 lb per min.
For higher velocities add or multiply values in table; thus,
14,000 = 2 × 7000.
What size pipe will deliver 2,000 lb of steam at 180 psig in 1 min?
Reciprocal of volume at 180 psig = 0.4266 and 2000 ÷ 0.4266 = 4,688 cu ft per min.
12-in. pipe gives 6,000 fpm; 10-in. pipe gives about 8,500 fpm from Table II.

(Continued from page 99)

cal qualities and conditions of the steam. The accompanying tables and charts help you find basic pipe and steam data. Knowing the above, a few simple calculations, as shown here, will give the amount of condensate forming in the line.

If the pipe is insulated or exposed to a wind, either or both of these factors will have an effect upon the amount of condensate formed. Example 1 shows how, with the above data, the total heat loss in bare iron pipe (or copper pipe) and fittings is accounted for, how the pounds of condensate is figured and what this loss means in dollars per year. It also shows how you can save much of this by insulating the pipe. Another later article will show how correct steam trapping will recover the maximum obtainable part of this loss.

II — How to Calculate Condensate for Typical Process Installation

There are innumerable types of manufactured equipment where the energy in steam is utilized—platens, jacketed kettles, mills, calenders and retorts, to mention a few. Here again the problem of determining the amount of condensate formed is not difficult, once the engineering data of the equipment and the conditions of the steam are known. Most manufacturers show on their equipment the amount of steam necessary at a certain pressure for maximum efficiency. Frequently this is given in boiler horsepower. (NOTE: A boiler horsepower is defined as "The evaporation of 34.5 pounds of water per hour from and at 212 degrees F." Since it requires 970.3 Btu to evaporate 1 lb of water into steam at 212 F, a boiler horsepower is 34.5 × 970.3 or 33,475 Btu per hr.

When this is known, the pounds per hour of condensate can be calculated by multiplying the blrhp by 33,475 Btu per blrhp and dividing this total Btu by the available heat per pound of steam—that is, the heat of evaporation of the steam. See the Steam Tables.

Here in Example 2 in simplified form are shown the method of accounting for the dimensions of a platen, the heat losses through the platen and in raising the temperature of water and, finally, how to compute the condensate load. It also shows how to compute the condensate when using materials other than steel and water.

III — How to Calculate Condensate in Submerged Coil Heating

Typical use of steam for submerged coil steam heating is shown in Fig. 5. In Example 3 for computing condensate for this condition, arbitrary conditions have been chosen; however, an explanation of

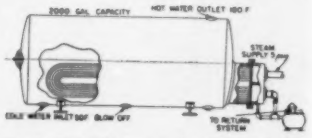


Fig. 5. Typical submerged coil water heater
In plants with water storage tanks inside buildings, temperature of the water is kept fairly constant throughout the year. This gives an even load for the steam supply as well as for the condensate to be trapped. Where the supply comes from the city water mains or other outside sources, large temperature differences are encountered, which might range from a minimum of 34 F in winter to a maximum of 85 F in summer. Because of the large range in temperature, calculations can only be approximate and great care should be taken with the extreme conditions. It is always safe and good practice to have the equipment over-sized within reasonable limits instead of under-sized.

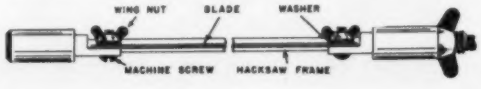
possible other conditions is given in the caption below Fig. 5. The manufacturer in some cases gives the boiler horsepower rating of the heater. When this is given, compute the condensate load by the same method as in Example 2.

When a material other than water is being heated, multiply the Btu required, as found in Example 3a, by the specific heat of the material to get the total Btu required.

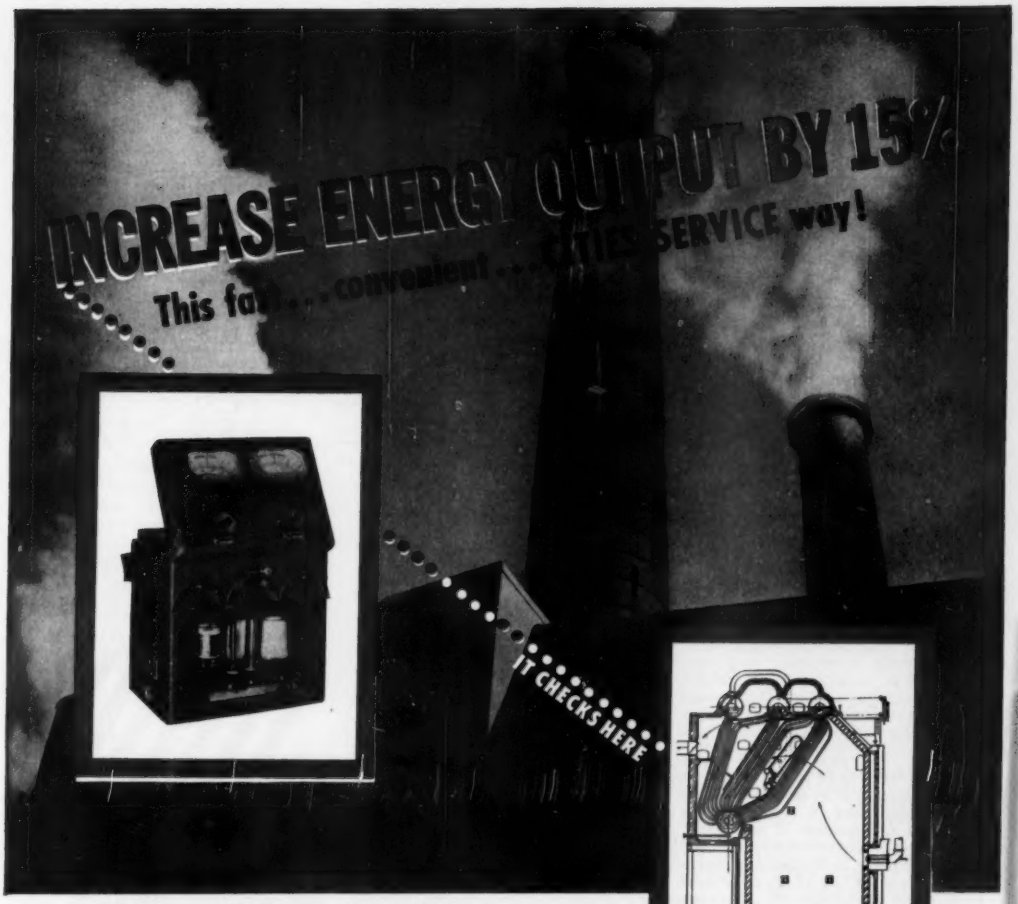
HACKSAW FRAME

By THOMAS TRAIL

IF THE PINS holding the blade in a conventional type hacksaw frame become broken, or worn excessively so that they no longer hold the blade rigid, they may be replaced with a pair of 6-32 round head steel machine screws, washers and wing nuts, as shown. These will hold the blade more rigid than even a new frame since the blade is securely clamped.



Showing the application of machine screws, washers and nuts to hacksaw frame



The Cities Service Industrial Heat Prover

This remarkable instrument is an exhaust gas analyzer, designed for use on industrial furnaces regardless of size or type. It is provided with three scales; one shows per cent of oxygen, another percentage of combustibles present and measured in the flue gas sample, and the third scale registers flue gas temperature.

A fuel analysis taken at this important checking point—during a free demonstration—has led to increases in energy output as high as 15%. The Heat Prover indicates the type of adjustments necessary to get maximum combustion efficiency.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

FREE—THIS HELPFUL BOOKLET

CITIES SERVICE OIL COMPANY
Sixty Wall Tower, Room 988
New York 5, N. Y.

Please send me without obligation your new booklet entitled, "Combustion Control for Industry."

*Name*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

THE PRACTICAL ENGINEER AND ELECTRICIAN

Automatic Control for Molding Machines

By HOWARD T. BAILEY
Supervisor, Electric Maintenance
Brillion Iron Works

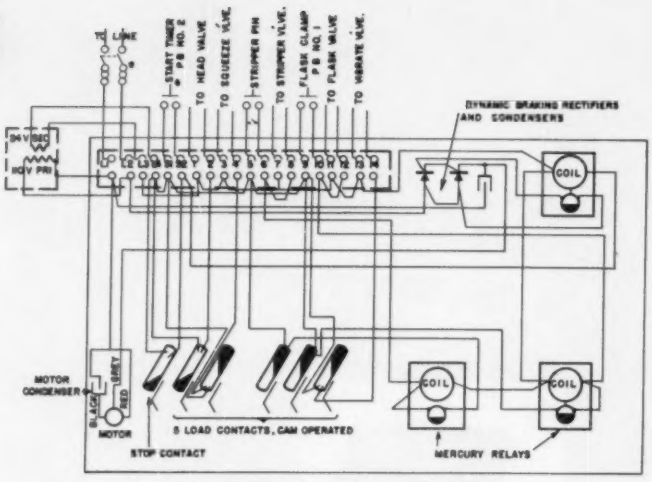


Fig. 1. Wiring diagram of control for molding machines

THE ADVENT of World War Two created a demand for more castings than the average foundry thought possible to produce.

Engineers of the Brillion Iron Works with the capable assistance of H. K. Leedy, consulting engineer, tackled the problem of installing automatic controls on a molding machine in order to obtain an increase in production and also a better quality mold.

Controlling all operations of a molding machine with a fixed time sequence resulted in a marked increase in the quality of the mold. The timing process eliminated all the human element in the head, squeeze and jolt valves, all of these operations being taken care of automatically be a cam-operated timing mechanism adjustable to any desired period.

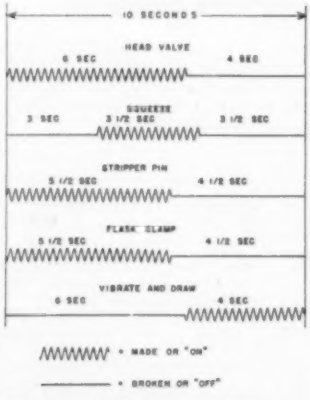


Fig. 2. Layout of sequence used in a particular occasion

The heart of the timing system is a Series 2400 cam timer produced by the Automatic Temperature Control Co. This timer is powered with a sychronous, unidirectional motor which drives a cam shaft through a gear train designed to rotate the shaft at any desired rate. Split cams mounted on the shaft are adjusted to actuate mercury switches for controlling the various solenoid valves. Figure 1 shows schematic of timer used in this installation.

The sequence of operation is as follows:

1. Press push button No. 1 to operate flask clamp via three way valve. Clamps are set and remain in this position until released later through contacts in timer.

2. Press push button No. 2 when all other manual operations have been performed up to a point of raising head. Push button No. 2 starts timing cycle and the following operations occure in sequence.

A. Head raises.
B. Squeeze.
C. Flask clamp release.
D. Table down.
E. Head back.

Note: These operations can be arranged in immediate sequence or overlapping.

3. Control is ready for next cycle.

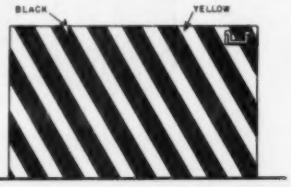
It will be of interest to note that all circuits to machine are at a potential of 24 v for safety.

Fig. 2 is the layout of the sequence (timing) used in this particular occasion.

Little difficulty was experienced in the adjusting and operation of the control although particular attention should be given to the size of solenoid valves used; valves that have ports of insufficient size will slow the operation of the machine and in extreme cases will result in complete failure.

SIDEWALK DOORS

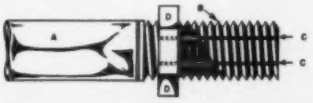
SIDEWALK DOORS covering basement entrances or lifts will be more noticeable when open if diagonal



yellow and black lines are painted on their top surfaces with enamel, as shown.

HOLDING THREADED PARTS

THREADED PARTS can be held in a vise without damage to the threads by holding as follows: Get a piece of copper tube about eight inches long and flatten one end as at A so that it can be gripped in a vise. The other end is threaded, as shown in the sketch, and a nut D screwed on. Then two hack saw slits, as shown at CC. When this is done the walls of B can be opened out at the mouth and then closed in again by screwing up the nut D. The mouth of B should be bushed with a strip of sheet lead. The part to be held



Scheme for holding threaded parts. A—Piece of copper tube, flattened to hold in a vise. B—Piece of copper tube threaded to take nut D-D. C-C—Hack saw slits in length of B so that the walls of B can be belled outward and forced inward again by screwing up nut D-D

should be placed in the slightly-opened out mouth of the tube in which it should be a loose fit. As the nut D is tightened up the part will be tightly gripped. Any thread will be forced into the lead and held without damage.

W. E. WARNER

Beryllium Discontinued in Fluorescent Lamp Manufacture

By DR. W. SCHWEISHEIMER

MANUFACTURERS of fluorescent lights after consultation with officials of the Public Health Service have stated that they will no longer use beryllium phosphor in the manufacture of fluorescent lights.

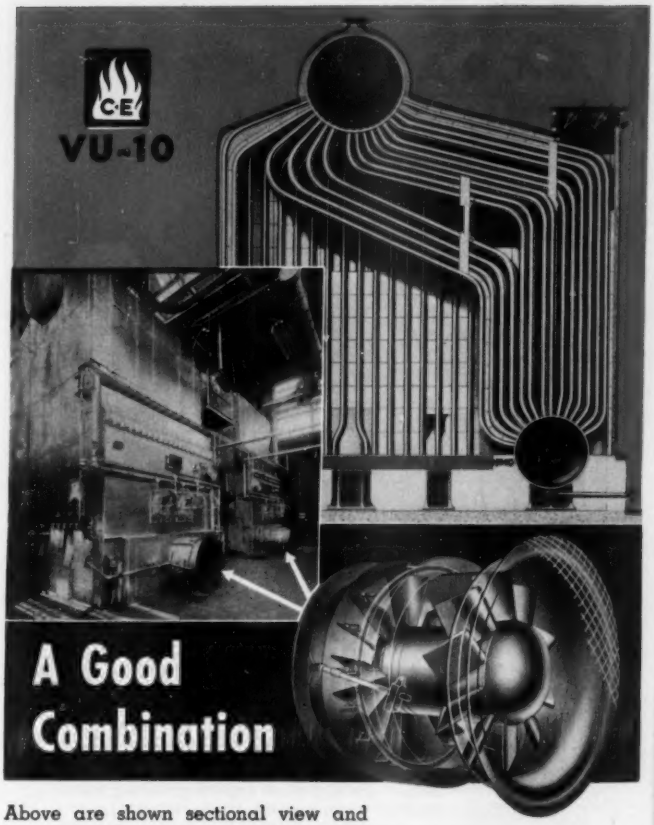
A committee which has been studying the results of work on beryllium for three years, has reiterated its assertion that there is no danger whatever from the lamps when they are intact. Chairman of the committee (Medical Advisory Committee on Beryllium) is Dr. James G. Townsend, Chief of the Division of Industrial Hygiene of the Public Health Service.

Dangers from Destruction of Old Lights

The possible dangers come in the destruction of old lamps. Recently there have been reports of children who cut themselves on broken lamps. The cuts healed slowly, and swelling was frequent. Such cuts do not cause general sickness or spread throughout the body. Surgical care is necessary if the lesion does not heal after a reasonable period of time. Although precautions should be taken against breathing the dust from broken fluorescent lights, the committee states that there is no record of any person suffering from the occasional breakage of a lamp, despite the millions of lamps in use.

The industries which use beryllium in some form include those which process the ore into alloys, and those manufacturing fluorescent lamps, radio tubes, electronic tubes, incandescent lamps, neon-sign tubing, X-ray-tube windows, electric heating elements, phosphorescent luminous indicators, refractories, etc.

There are two general manifestations of beryllium poisoning: on the skin and on the respiratory organs. The skin lesions have been somewhat overshadowed in the



Above are shown sectional view and actual installation of Combustion Engineering-Superheater's Vertical Unit Boiler Type VU-10. Installation shows two 27,000 lb. oil-fired units equipped with Wing Axial Flow Forced Draft Blowers. This integrated design of steam generator combines boiler, water-cooled furnace and fuel burning equipment in one soundly coordinated unit.

WING FORCED DRAFT BLOWERS are noted for:

1. Simple, rugged construction
2. Compact Design
3. Highest Efficiency
4. Quiet Performance
5. Built-in Voltrol Vanes (capacity regulating and re-directing vanes)

Wing

AXIAL FLOW BLOWERS

L. J. Wing Mfg. Co.
64 Vreeland Mills Road
Linden, N. J.
Canadian Factory: Montreal

Small cracks in your furnace insulation can add up to real money wasted. Best preventive is "48" High Temperature Insulating Block and Weber's "48" Insulating Cement for the whole job . . . Next best is a good patching job that will *stay* patched when you use Weber's "48" Insulating Cement to repair dozens of cracks at a fraction of the cost of heat you lose through them.

For high temperatures (up to 2400° F) or low (down to -200° F), there are "48" blocks, cements, felts, blankets and loose wool to handle every insulating job effectively. Write for your copy of the "48" Industrial Insulations Catalog today . . . And remember the high cost of small cracks next time you inspect your furnace and equipment insulation.

**Calculated for ¼" x 2' crack; hot wall to cold wall temperature differential, 850° F.—giving 5500 B.t.u. loss/hr.; coal: 10,000 B.t.u./lb.*

FORTY-EIGHT INSULATIONS INCORPORATED
AURORA, ILLINOIS

Send my copy of the "48" Industrial Insulations Catalog to:

NAME _____

TITLE _____

COMPANY _____

STREET _____

CITY _____ STATE _____

literature by the more serious lung lesions. Grier, Nash and Freiman, Boston, have stated that the following skin lesions have been noted in those who come into contact with beryllium compounds: dermatitis (inflammation of the skin); skin ulcer, subcutaneous granuloma (growth under the skin) occurring in persons who cut themselves on fluorescent lamps.

Here is an example of beryllium injury as described by the publication of Grier and his co-research-workers from Harvard University. A 12-yr-old boy complained of small, painless swellings around the angle of the jaw on the right side. Three months previously he had been playing with some friends at a dump where there were some old fluorescent lamps. One of the boys hit a bottle with the lamp. The lamp broke and pieces of glass from it cut the patient on the right side of the neck. The doctor removed some pieces of glass and cleaned and sutured the wounds.

Eight weeks later some small lumps were appearing beneath the scars on the boy's face and neck. At operation it was hard to remove the lumps because of their adherence to the tissue under the skin. Two very small pieces of glass were found. The tissue removed was analyzed spectroscopically for beryllium. It was found to contain 27 micrograms of beryllium per 100 gm tissue, a rather high concentration. Two months after the operation another lump appeared on the site of the injury which also was removed by operation.

Beryllium Content of Lamps

Essentially all fluorescent light bulbs manufactured in America, according to the statement of manufacturers of fluorescent lights mentioned, had contained a phosphor with varying quantities of zinc beryllium silicate (1.4 zinc, 0.6 beryllium), manganese and small amounts of finely dispersed mercury. Drs. A. D. Nichol and Refael Dominguez, Saint Luke's Hospital, Cleveland, stated that the beryllium content of these phosphors has varied from approximately 2 to 15 per cent, expressed in terms of beryllium oxide. Since 1943 all manufacturers had used a low beryllium phosphor.

The authors have described granulomas of the skin due to accidental contamination with beryllium phosphors. In two of their cases the beryllium content of the phosphor was taken to be 2 per cent. In two other cases the phosphor used never exceeded 4.0 per cent beryllium oxide, that is, less than 1.5 per cent, by weight of beryllium.

In another case, described by Drs. Coakley, Shapiro, and Robertson, Kings County Hospital in Brooklyn, a 16-yr-old boy had a painful nodule on his left cheek combined

with a discharge which had to be removed by operation. Two years before, while playing with burned out fluorescent bulbs, he had broken one and was cut on his left cheek, on two places. At present, surgical intervention appears necessary in these cases. Wider experience may give the possibility of a non-operative treatment, with irradiation for instance, but so far, operative removal of the growth has been the best method.

Precaution Necessary with Used Fluorescent Lights

The safest way to dispose of used fluorescent lights is to break them out of doors in a waste area or in a waste container; the person who breaks them should avoid breathing the dust or vapor that arises. Another situation in which there is possible danger is the breaking of large numbers of fluorescent bulbs, either intermittently or regularly, with the time required for the operation running into hours. The Medical Advisory Committee on Beryllium has issued these instructions in such cases:

(a) Break the lamps out of doors in waste-disposal area or in ventilated hood. To avoid unnecessary dust, the breakage is best done within the waste container.

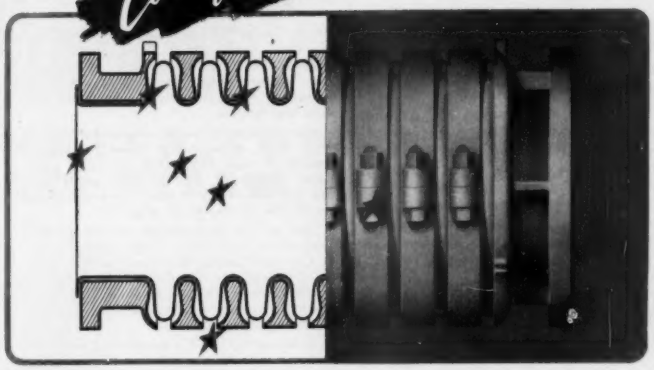
(b) The operator should be supplied with, and required to wear, a respirator approved by the United States Bureau of Mines for toxic dusts.

(c) Ultimate disposal of broken lamps should be such that the public and others will not be unduly exposed to powders. In situations where it is necessary to break the lamps within buildings, it should be done in an isolated room and in a ventilated hood, so as to minimize escape of dusts.

Broken lamps, the Committee says, should not be placed in an incinerator. They should either be thrown into water or in a dump where they are not likely to be disturbed with a resulting evolution of dust. Significant amount of mercury vapor may be found in the air during the breaking of fluorescent lamps. When exposure is frequent or continuous, measurements should be made of the amounts of mercury vapor in the air during the operation. If high levels are found, protection should be provided for the operator.

Rare metals which a few years ago were laboratory curiosities, such as beryllium, have suddenly assumed important roles in industry. As a result, new kinds of diseases are being encountered. Beryllium injuries though obviously increasing in numbers, are not very common. Still it belongs to the metals almost unknown in industry as recently as ten years ago which mean new problems to industrial medicine and preventive hygiene.

ADSCO *Corruflex* is better because...



no other packless expansion joint combines ALL these features!

- **NO MAINTENANCE.** Since the corrugated element, made from a single tube of copper or stainless steel, is a flexing member designed to absorb expansion or contraction, no packing of any kind is necessary.
- **LONG LIFE.** The element is formed hydraulically to ensure uniform wall thickness. Annealing during and after forming relieves all internal strains. Flexing stresses are evenly distributed and are not concentrated at welds or diaphragms.
- **UNIFORM RAISED FACE.** Element is hydraulically lapped over the end flange to form smooth, even face for joining to mating pipe flange.
- **EQUALLY DISTRIBUTED EXPANSION.** Equalizing rings of cast iron or steel control individual corrugation expansion and reinforce element walls.
- **STURDY CONSTRUCTION.** Heavy lugs and rings are cast in a single piece, accurately machined into halves and kept in pairs to ensure a tight joint.
- **COMPLETELY SUPPORTED ELEMENT.** Both end flanges and rings are contour shaped, scientifically designed to support element throughout its entire length. All inner surfaces are carefully hand-finished.
- **COMPACT.** Maximum outside diameter is only slightly larger than that of the flanges. Ideal for installation in cramped quarters.

Corruflex Joints are available in sizes from 3" to 24", single or double units, single or multiple corrugations, with or without self-equalizing rings, and with flanged or welding ends. Supplied in copper, stainless steel or other alloys and with internal sleeves if required.

Corruflex Joints have traverses ranging from fractions of an inch to 15" and operate under pressures from vacuum to 300 psi and temperatures from sub-zero to 1600F.

ADSCO offers the most complete line of expansion joints—both packed and packless—available from any manufacturer. For an impartial recommendation, consult the company that makes all types.

Send for New 16-page Bulletin No. Y-35-51

Explains design and construction and completely describes the line . . . sizes, temperature and pressure ratings, dimensions and weights. Simplified selection charts make it easy to determine proper joint for most applications. Recommended installation practice is summarized.

Expansion Joints
Steam Traps · Meters
Anchors · Guides

ADSCO Since 1877

Heat Exchangers
Strainers · Separators
Casing · Supports

AMERICAN DISTRICT STEAM COMPANY, INC. • North Tonawanda, N. Y.

Questions and Answers

Question No. 478

HE WANTS DATA ON SIMULTANEOUS FIRING OF COAL AND GAS

CAN YOU refer me to any articles or give me information on simultaneous firing of coal and gas fuels in low-pressure (225 psig) industrial power plants?

We are particularly interested in the possibility of firing these fuels simultaneously in the approximate ratio of 80 per cent natural gas to 20 per cent Midwest bituminous coal, the coal being burned on forced-draft type chain grate stokers.

Camden, N. J. G. B. K.

Question No. 479

HOW SHOULD SMALL PLANT STORE AND HANDLE HIGH-MOISTURE COAL?

IN AN ARTICLE entitled Moisture in Coal by A. F. Rieber in the August, 1950 issue of POWER ENGINEERING, Mr. Rieber states that "moisture in coal is a veritable bugaboo in plants using pulverized coal" and says that "it must be dried before going to the mills."

During the past six or seven years, we have maintained an open stock pile of coal screenings and have experienced considerable trouble in feeding and burning it as pulverized fuel when it is reclaimed, because of its high moisture content.

How can this type of coal be stock piled economically so that it will be in usable condition when it is reclaimed? We want to maintain a reserve stock of 600 tons for each of two plants (approximately two months supply).

Also, we would appreciate suggestions on how to burn the coal in pulverized form from the present stock pile. Obviously, for a small operation, the cost of an extensive coal conditioning system is prohibitive.

At the recent annual meeting of the ASME, a paper was presented on Coal Handling Methods at Today's Power Plants. This was devoted mainly to large installations but it was significant to note the interest among smaller operators which developed in the discussion period, when I raised the question of coal handling for small plants. It led me to believe that many of your readers might have some valuable suggestions on the subject.

Pennsylvania H. E. F.

Editor's Note: It is true that most of the literature on coal storage and handling in recent years has referred to relatively large plants. Nevertheless, considerable attention has been given to small plant problems.

In particular, we published an article entitled Design of Small Power Plants, by H. C. Carroll, *Power Plant Engineering*, August, 1945, which emphasized particularly the need for simplicity and low cost in equipping small power plant coal and ash handling systems.

Also, a long series of articles by Wilbur G. Hudson, appearing in *Power Plant Engineering* through 1945, 1946 and 1947 gave many details of coal-handling equipment and methods, many of which were especially applicable to the small plant.

One of the best recent studies of this subject was made in a paper entitled How to Cut Small Boiler Plant Costs by Mechanical Coal and Ash Handling, by C. E. Miller, H. M. Carlson and R. B. Engdahl of Battelle Memorial Institute, published in 1949 by Bituminous Coal Research.

In answering H.E.F.'s question, it must be remembered that the amount of coal to be stored is relatively small, 600 tons per plant. He does not say how much moisture there is, nor what kind. Should the coal be stored on the ground, or in silo or other type of bunker? How can he get it out of storage economically?

In small plants, can coal drying systems be justified? Can such a system be designed simply and at low cost? It's easy enough after you get the coal into the pulverizers; you can dry with flue gas or primary air. But clogging of chutes, gates, etc., by wet coal is the real headache.

In ground storage, use of earthmoving equipment has become quite common, even for small plants. (See Coal Storage Manual, *Power Plant Engineering*. Also, Handling Coal by Tractor Equipment, by E. A. Rudulph, *Power Generation*, March 1949.) Even a big truck equipped with a scraper blade can be quite effective. How about the drag scraper?

Answer No. 475

HOW SHOULD HE FIGURE STEAM ENGINE STRESSES?

WHAT ARE THE stresses in crank pin and wrist pin in a 500-hp steam engine with 24-in. stroke, 20-in. bore, piston rod 4 in. in diameter, throttle steam pressure 150 psig? What formulas are used to figure these stresses? These questions were asked by G.J.T. in the December issue.

Here are several good answers, differing somewhat in methods of calculation, and in results, because of the necessity of making assumptions about diameter of the pins, which G.J.T. did not give.

We suspect that he is not entirely clear in his own mind about the difference between force, unit stress and so on. However, the fact that some of the necessary data must be assumed is useful for it leads the answerers to bring out details of calculation and explanation that they might not have given otherwise. The important thing is the method.

Calculations by Skillestad

THE PROBLEM can be made very interesting by assuming some of the values, as a machine designer does in designing such an engine. Maximum steam force on the piston will be at the head end, therefore we need not consider the lesser force at the crank end where the effective area is smaller by the obstruction of the piston rod area.

This force is $F = 0.7854\ PD^2$ where P = steam pressure psig and D = diameter of piston in inches. Substituting the values given, $F = 0.7854 \times 150 \times 20^2 = 47{,}000$ lb.

The maximum thrust Q will come on connecting rod when the crank is perpendicular to the line of motion of the cross-head, as shown in Fig. 1 (neglecting the small difference from 90 deg). If F is the total pressure on the piston then from similar triangles: $\frac{Q}{F} = \frac{ab}{ac} = \frac{ab}{\sqrt{ab^2 - bc^2}}$

$$= \frac{L}{\sqrt{L^2 - R^2}} \text{ and } Q = \frac{FL}{\sqrt{L^2 - R^2}}$$

where L = length of connecting rod in feet and R = length of crank arm in ft. The length of the connecting rod is commonly 5 times the crank arm length. Let $n = \frac{L}{R} = 5$, then

$$Q = \frac{FL}{\sqrt{L^2 - R^2}} = \frac{Fn}{\sqrt{n^2 - 1}} =$$

$$\frac{47{,}000 \times 5}{\sqrt{5^2 - 1}} = 48{,}000 \text{ lb}$$

which is the maximum stress on crank pin and also the wrist pin. The connecting rod is to resist a compression of 48,000 lb, therefore the two ends, which are an integral part of the connecting rod, must also resist this force or stress.

Crank pins are journals and the important consideration in their design is to prevent heating by keeping the bearing pressure within safe limits. The stresses to which the pin is subjected should in all cases be calculated to be sure they are within the safe limits for steel of which all such pins are made.

Now let q = the allowable bearing pressure in psi on crank pin, d = diameter of crank pin in inches and l = length of crank pin in inches. Let n^1 = ratio of length of pin to its diameter or $n^1 = \frac{l}{d}$ and $l = n^1 d$.

For medium speed engines, $n^1 = 1.0$ to 1.4 and q = 600 to 900 psi. The total bearing pressure = Q = qld. We will assume $n^1 = 1.25$ and q = 750 and substituting these values in the above formula and solving for d we have $d = \sqrt{\frac{Q}{n^1 q}} = \sqrt{\frac{48{,}000}{1.25 \times 750}}$

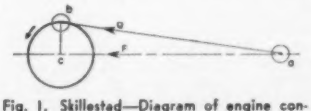
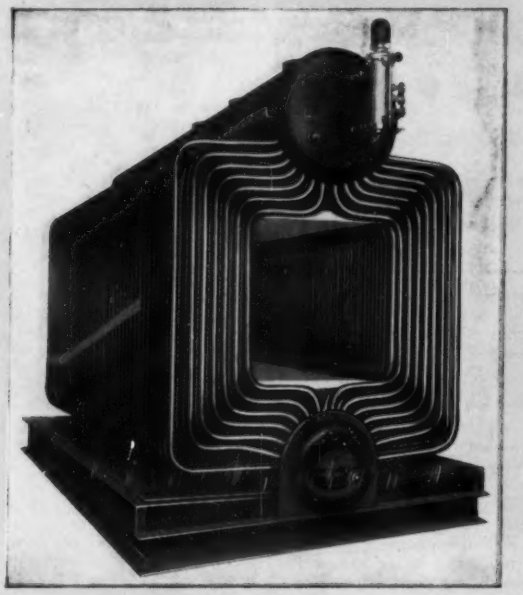


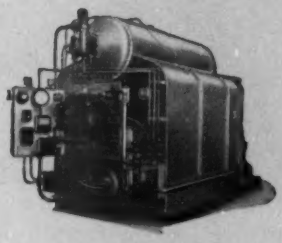
Fig. 1. Skillestad—Diagram of engine connecting rod and crank

KEYSTONE STEAM GENERATOR

Offers

2-DRUM WATER TUBE DESIGN IN A COMPACT STEAM GENERATOR

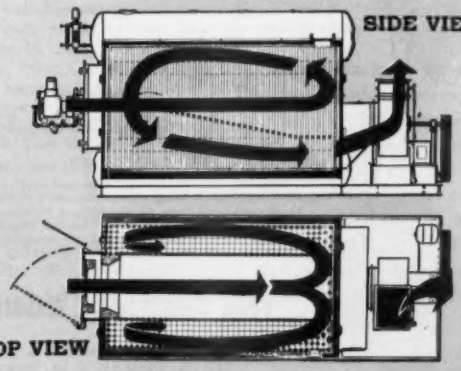




Here's big boiler performance in small cubage. Keystone combines in a factory assembled unit: low head 2-drum water tube boiler complete with boiler trim, a heavily insulated steel casing — automatic burner for gas, oil or both interchangeably — induced draft equipment and instrument panel with all controls mounted. Complete range of sizes from 75 to 800 hp. at pressures from 160 p.s.i. Write for Bulletin SB-38.

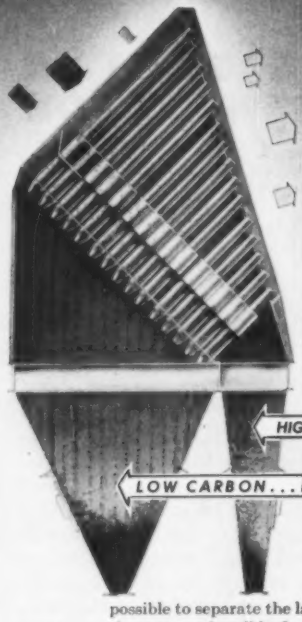
Note THE UNIQUE 3-PASS GAS TRAVEL

Hot gases contact solid side banks of water tubes in first pass to the rear of the Keystone, divide to left and right and are deflected upwards and over inclined baffles in both side water tube elements, again contacting bare metal heating surfaces—make return or third pass under these baffles, contacting bare metal again in the return trip to the rear and out of the boiler. Quiet induced draft fan provides all the draft required for top ratings. Spent gases need only be vented. No stack is required.



ERIE CITY IRON WORKS *1412 East Ave.* **ERIE, PA.**

REFIRE HIGH CARBON DUST
without recirculating fly-ash

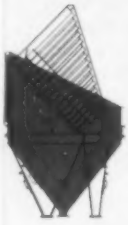


. . . install **pd**

TUBULAR DUST COLLECTORS *arranged for* DECANTATION

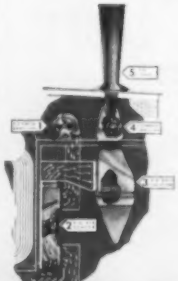
In a single phase P-D tubular collector, designed for decantation and *requiring no additional pressure drop*, it is now possible to separate the large particles of high carbon content from the non-combustible finer particles.

Fly-ash from spreader stoker-fired units, consisting of up to 40% high carbon particles, can effect considerable savings when re-injected. It is necessary to effect separation, however, since the non-combustible smaller particles remaining in the system increase in concentration, causing erosion and possible poor combustion due to spotting.



Space requirements for the decantation design are not as great in area and only slightly higher than a standard tubular . . . and, collection efficiency is high. Superimposed sketch shows comparative size.

Why waste fuel? Investigate this collector today, it will soon pay for itself. Write our Sales and Project Engineers for Bulletin 260 D.



UNIT RESPONSIBILITY

Prat-Daniel, through its sales and project engineers, The Thermix Corp., offer a complete complement for handling the air gas stream: Forced Draft Fans, Air Pre-heaters, Tubular Dust Collectors, Induced Draft Fans and Fan Stacks. This unit responsibility, by a well known firm, relieves the engineer of the responsibility for one of the most important functions in a steam generating plant.

Sales and Project Engineers

THE THERMIX CORPORATION
GREENWICH, CONN.

Canadian Affiliates: T. C. CHOWN, LTD.
1440 St. Catherine St. W., Montreal 25, Quebec
50 Abell St., Toronto 3, Ontario

Designers and Manufacturers

PRAT-DANIEL CORPORATION
EAST PORT CHESTER, CONN.

$= 7.13$ or say 7¼ in. diameter. $l = n^1d = 1.25 \times 7.25 = 9.06$ or say 9 in. length.

The overhung crank pin is a cantilever, as can be seen in Fig. 2, where the maximum bending moment is $M = \frac{Pl}{2}$, where P is the total load or 48,000 lb. The moment of resistance of the circular section or section modulus is $\frac{\pi d^3}{32}$ and therefore $\frac{Pl}{2} = \frac{\pi d^3 s}{32}$ where s = the safe tensile stress, which for steel is 6000 to 9000 psi. Now solving for s and simplifying $s = \frac{5.1\,Pl}{d^3} = \frac{5.1\,(48{,}000)9}{7.25^3} = 5770$ psi which is safe. In Fig. 2 we can see that the crank pin is in single shear or $S_s = \frac{P}{A}$ where S_s = safe shearing stress psi = 10,000 maximum. Then $S_s = \frac{48{,}000}{0.7854 \times 7.25^2} = 1162$ psi which is 'way on the safe side.

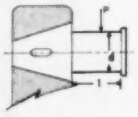


Fig. 2. Skillestad—Diagram showing how crank pin is a cantilever

The method of calculating the diameter of the wrist pin is identical with that of the crank pin, using the same symbols and the same formula $d = \sqrt{\frac{Q}{n^1 q}}$ The value of n^1 for wrist pins is 1.15 to 1.75 and the allowable bearing pressure q ranges from 700 to 1400 psi. Let us again assume $n^1 = 1.25$ as we did with the crank pin and q = 1000 psi then $d = \sqrt{\frac{48{,}000}{1.25 \times 1000}} = 6.18$ or say 6¼ in. diameter. $l = n^1 d = 1.25 \times 6.25 = 7.81$ or say 7¾ in. length.

Having calculated the diameter and length based on allowable bearing pressure it is necessary to check design for stress. Assuming the load to be uniformly distributed over pin as in Fig. 3, the maximum bending moment is $M = \frac{Pl}{8}$ and therefore $\frac{Pl}{8} = \frac{\pi d^3 s}{32}$ where S = safe tensile stress and this should not exceed 5000 psi.

Now solving for S and simplifying, $S = \frac{1.27\,Pl}{d^3}$ and substituting, $S = \frac{1.27 \times 48{,}000 \times 7.75}{6.25^3} = 1930$ psi which is amply safe. Now to check for

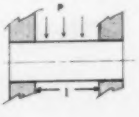


Fig. 3. Skillestad—Diagram showing how load is distributed over wrist pin

● DETROIT STOKERS
In Plants of Peter Cooper Corporations

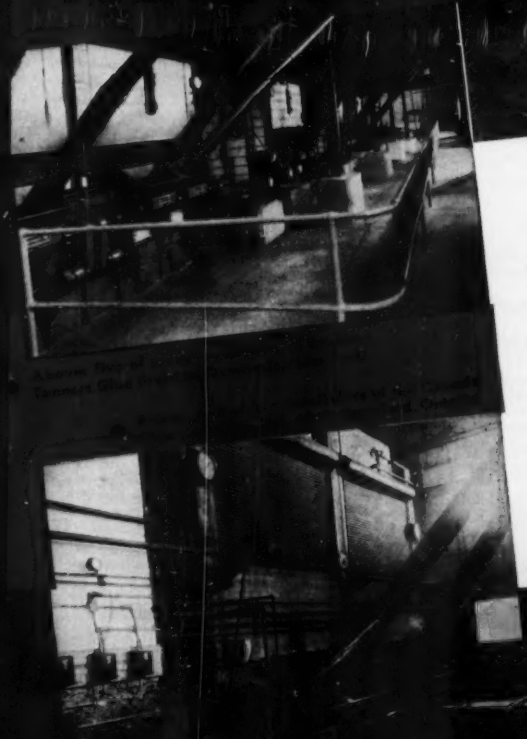
Eastern Tanners Glue Division
Gowanda, N. Y.
1939—Five Detroit RotoStokers
1943—Two Detroit RotoStokers

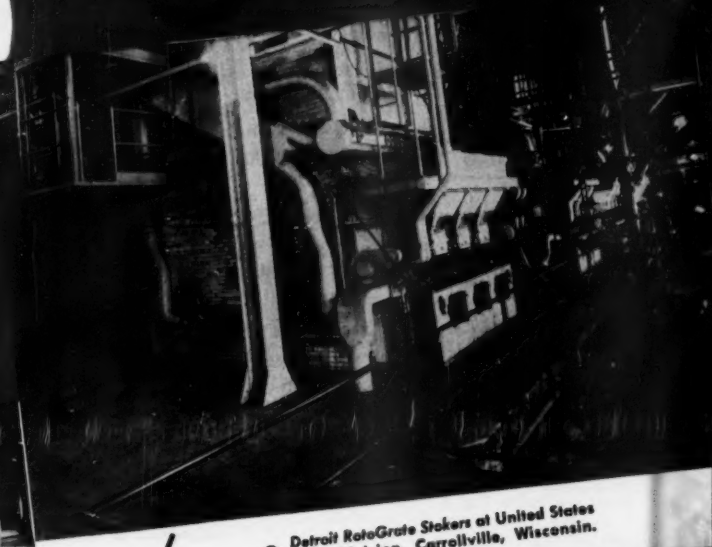
Canada Glue Company, Ltd.
Brantford, Ontario
1939—Three Detroit RotoStokers
1946—One Detroit RotoStoker

Diamond Glue Division
Chicago, Illinois
1944—Two Detroit RotoStokers
1945—Two Detroit RotoStokers

United States Glue Division
Carrollville, Wisconsin
1946—Two Detroit RotoGrate Stokers
1947—Two Detroit RotoGrate Stokers

DETROIT STOKERS





● Detroit RotoGrate Stokers at United States Glue Division, Carrollville, Wisconsin.

Peter Cooper (1791-1883) was one of the great pioneers of American Industry. Entering the glue and isinglass business early in the 19th Century, he ranged into many fields of endeavor. He built "Tom Thumb", the first locomotive built in America—was early in the iron and steel business—made the first rolled structural beams —was the first in U. S. to use the Bessemer steel making process. He also furnished much of the cash for laying the first Atlantic cable. Cooper is most famous for the Cooper Union, New York City, which he founded in 1859. Here, in 1860, Abraham Lincoln made the famous speech which opened his way to the presidency

DETROIT SINCE 1898 STOKERS

THERE IS A TYPE AND SIZE OF DETROIT STOKER FOR EVERY INDUSTRIAL OR POWER NEED

DETROIT STOKER COMPANY

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

District Offices in Principal Cities — Works at Monroe, Michigan

shear, this pin is in double shear or

$$S_s = \frac{P}{2A} = \frac{48{,}000}{2 \times 0.7854 \times 6.25^2}$$

= 783 psi, which is plenty safe.

I think it would be very interesting for G.J.T. to check on the dimensions of the crank pin and wrist pin of the engine he refers to and see how close our figures come to the actual.

Chicago, Ill. ROY O. SKILLESTAD

Calculations by Allbert

STRESS or "unit stress"[9] is the amount of internal force per unit area of the section. This is given in pounds per square inch. In order to determine stress in pounds per square inch it is necessary to have wrist pin diameter and also diameter and length of the crank pin. However, if we assume a steam engine

Fig. 1. Allbert—Plan diagram of typical steam engine crank and connecting rod

layout as shown in Fig. 1, formulas for the various stresses can be given and the area of various sections inserted by G.J.T. to get the final answers.

Force on piston rod = Pressure $\times$ Area = $150 \times \frac{\pi D^2}{4}$

where $\pi = 3.1416$ and $\frac{\pi}{4} = 0.7854$.

$= 150 \times 0.7854 \times 400$

= 47,100 lb

This force F is transmitted to the wrist pin, as in Fig. 2.

Force F tries to bend the wrist pin and at the same time to shear it where it bears against the crosshead. Bending stress can be neglected in this case since, in all likelihood, it is too small to be considered.

Shear stress $= \frac{F}{2A}$, A being the area of the section of the crank pin at the tapered fit in the crosshead. Note that 2A is used because the wrist pin is supported at both ends. If, for example, the wrist pin diameter is 5 in., then crank pin shear stress

$= \frac{47{,}100}{2 \times 0.7854 \times 5^2} = 1200$ psi.

Force F next goes on to the crank pin through the connecting rod, Fig. 3. Force F tries to shear off the crank pin and bend it at the same time.

Shear stress $= \frac{F}{\text{Area Crank Pin}}$

only one A being used because the crank pin is supported on one end only. If crank pin diameter = 7 in., then shear stress $= \frac{47{,}100}{0.7854 \times 49} =$ 1223 psi.

Fig. 2. Allbert—How force is transmitted to wrist pin

The bending stress caused by F, Fig. 3, can be figured as follows:

$$\text{Stress} = \frac{\frac{F \times L}{2}}{Z}$$

where F = 47,100 or pressure $\times$ area of piston

L = Length of crank pin — connecting rod bearing length

Z = Section Modulus; for a circle, $Z = \frac{\pi D^3}{32} = 0.0982\ D^3$

For example, if we assume that the length of the crank pin bearing is 6

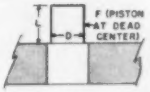


Fig. 3. Allbert—How force is applied to crank pin

in., then the bending stress would be:

$$\text{Stress bending} = \frac{47{,}100 \times \frac{6}{2}}{0.0982 \times 7^3} =$$

4190 psi.

I want to add that the above solutions give only a very rough idea of the stresses involved, since no consideration was given to dynamic forces or cushion pressures at dead centers, which might well cause the pressure in the cylinder to exceed our figure of 150 psig. If G.J.T. has cause to be concerned about high stresses in this particular steam engine, he could probably get the manufacturer to give him the design stresses very much in detail.

Topeka, Kansas V. P. ALLBERT

Calculations by Holt

SHEAR LOAD on crank pin and crosshead pin due to pressure of steam on piston is given by following formula:

$L_s = Ap$

where L_s = maximum shear load on pins due to steam pressure, lb

A = piston area, sq in.

p = maximum unbalanced steam pressure on piston, psi.

Using values for GJT's engine (assuming that back pressure is 0 psi gage, and that there is no tail rod):

$L_s = 314.16 \times 150 = 47{,}124$ lb.

If this question is from an engineer's license examination, and only the information as quoted is given, probably the above is the only answer expected.

In reality, however, the load on the pins is equal to the algebraic sum of the load due to the steam pressure and the load due to the inertia of the reciprocating parts. There is no simple formula for exactly calculating the latter.

To find the unit shear stress in psi, in the pins, use the following formula:

$$S_s = \frac{L_s}{0.7854\ d^2}$$

where S_s = unit shear stress in pin, psi

d = pin diameter, in.

Atlantic City, N. J. ARTHUR HOLT

Calculations by Braski

G.J.T. does not give sufficient information to calculate stresses in either crank pin or wrist pin of his steam engine. Sizes and lengths of both would be required. However, from the data given, disregarding inertia forces, a simple calculation can be made to determine the force acting on both the crank pin and wrist pin, as follows:

Force acting along piston rod

= Steam Press. $\times$ Piston Area

$= 150 \times 0.7854 \times 20^2$

= 47,100 lb

This is a maximum force and occurs at the beginning of the stroke before steam expansion has started. All other values of this force throughout the length of the stroke are less because the steam pressure is decreasing in expansion and the force itself is applied at an angle.

In order to illustrate a stress calculation, we have assumed a crank pin 6 in. in diameter and 6 in. long.

The shear stress in the crank pin would be as follows:

S_s = Shear Stress = $\frac{\text{Force}}{\text{Cross sectional Area of Pin}}$

$= \frac{47{,}100}{0.7854 \times 6^2} = 1670$ psi

The bending stress occurring at the base of the crank pin is calculated as if the pin were a beam:

F = Total force on pin = 47,100 lb

W = Uniform load per inch = $\frac{47{,}100}{6} = 7850$ lb

M = Bending Moment = $\frac{Wl^2}{2} = \frac{7850 \times 6^2}{2} = 141{,}500$ in lb.

Z = Section Modulus = $\frac{\pi d^3}{32} = \frac{\pi \times 6^3}{32} = 21.2$

S_s = Bending Stress = $\frac{\text{Bending Moment}}{\text{Section Modulus}} = \frac{141{,}500}{21.2} = 6680$ psi

As indicated above the bending stress is greater than the shearing stress and the pin would have to be made heavy enough to take this bending. For shock load, such as we have in a steam engine, I believe the 6680 psi stress is too high to provide a proper factor of safety. I hope the crank pin on G.J.T.'s engine is 7 in. or over.

Painesville, Ohio N. J. BRASKI

Calculations by Yavitch

FOR THE solution of the problem, we need to know:

1. The bore
2. The wrist pin diameter
3. The crank pin diameter
4. Steam pressure at throttle.

G.J.T. supplies us with items 1 and 4 only, therefore we must show him the method of computing the stresses and, to get the exact values, he will have to the substitute the exact size of his wrist and crank pin diameters.

The accompanying sketch gives elevation and plan views of a conventional steam engine with all the essential parts. The position shown is just after the admission valve opens to admit steam into the engine cylinder. The small arrows show the force per unit area of piston which in our case is 150 lb, if the engine is noncondensing. If it is a condensing unit, say with a perfect vacuum, then the force acting on the piston per unit area is the sum of the throttle pressure and 14.7 or a total of 165 lb. In the event of a back pressure, whatever value, then there will be a net force acting on the piston. The exact volume is between 165 and 150. For our purpose we shall assume 165. In problems of stress one must assume less favorable conditions.

$P = p \times a$ ..... (1)

P = total pressure (force), lb
p = unit pressure, psi
a = area of bore, sq in.

Substituting our values in (1), we get $P = 165 \times \frac{\pi}{4} \times (20)^2 = 51{,}800$ or 52,000 lb in round figures.

This force of 52,000 lb is transmitted to the wrist pin through the piston rod and crosshead, and through the connecting rod to the crank pin. At the crosshead, force P divides itself in two equal forces 52,000 ÷ 2 = 26,000 lb. The wrist pin is now subjected to a shearing stress.

Now stress, S = Force divided by area of pin $= 26{,}000 \div \frac{\pi}{4} 20^2$,

where 'd' is diameter of pin
$\pi/4$ equals 0.7854 and the 26,000 becomes 33,000.

Assume 1-in. diameter pin, the stress is 33,000 psi. This is too high.

Assume a 2-in. pin, the stress is 33,000 ÷ 4 or 8 or 8,250 psi. And so on.

For the crank pin, the value is double, since the total force of 52,000 lbs acts on the area.

$S = 52{,}000 \div 0.7854\ d^2 = 66{,}000$

Again, for in 1-in crank pin, the stress is 66,000, much too high for shear. For a 2-in. pin, it is 16,500 psi. For a 3-in. pin, it is 7,330 psi.

Philadelphia, Pa. Y. YAVITCH

Calculations by Dean

IN THIS question, it was not stated whether engine was a center crank or an overhung crank engine, nor the sizes of the pins. In the case of a center crank engine, the whole crank shaft would have to be considered, taking account of torque, stiffness to withstand the unbalanced pressure of the piston, the load of the flywheel, and so on. Crank pins,

BUY REGULATION

BUY FOSTER

WHEN you spend money for a reducing valve, a temperature regulator, a pump governor, or any other type of automatic valve, what you're actually buying is *regulation*—not just a valve.

Today it is important to pick the *right* valve the *first* time. Because, with the increased demand for all types of equipment, you may not get a *second* chance.

It should be *right* 3 ways: 1) . . . to give you the regulation you need. 2) . . . to give you years of service. 3) . . . to require the least down-time for repairs.

Foster Valves meet the requirements:

1) . . . There's a type and size of Foster Automatic Valve for every service requirement, so that you can get the regulation you need without makeshifts.

2) . . . For more than 70 years Foster has been building valves that stand up. Many have been in constant service for thirty years and more.

3) . . . Foster Valves are designed so that when normal inspection and overhauls are required, accessibility makes the job quick and easy.

Foster Engineers are qualified and ready to help you get the right valve.

Buy Foster

SEE OUR CATALOG IN SWEET'S

FOSTER ENGINEERING Company

R·P&C
VALVES

NO. 6656
Forged
Steel
Gate Valve

Here is a Premium Valve
that is NOT premium priced

CHECK THESE DESIRABLE FEATURES:

- Bolted bonnet construction
- Heat-treated and hard chrome plated stainless steel wedge
- Stainless steel gland eye-bolts and nuts
- Two-piece gland and follower
- Tongue and groove bonnet joint

It's well designed. It's low priced in its field.
See your R-P & C distributor or write nearest R-P & C district office.

R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

"Intrinsically Better"
READING-PRATT & CADY VALVES

wrist pins and journals of all kinds are not designed from the point of strength alone but are made of such a diameter and length that the unit pressure per square inch of projected area (diameter times length) does not exceed a certain value, which has been found in practice to give quiet and cool running of the journal and bearing. That is, the unit pressure is kept low enough so that the lubricant is not squeezed out from between the journals and bearing. Generally this gives a journal larger than if designed for strength alone.

In an overhung crank pin, the greatest stress is caused by the tendency of the pin to bend, and the stress is figured as if the pin were a cantilever beam of circular cross-section uniformly loaded. The pin is also in single shear.

Let P = unbalanced pressure acting on the piston

P = area of piston in square inches times steam pressure minus back pressure

l = length of crank pin in inches

d = diameter of crank pin in inches

$$\text{Stress due to bending} = \frac{5.1\,Pl}{d^3}$$

$$\text{Stress due to single shear} = \frac{P}{\text{Area of Pin}}$$

In the case of the wrist pin, bending action and shear also take place, but the pin is supported at both ends, so stress is figured as if the pin were a simple beam of circular cross section, uniformly loaded.

$$\text{Stress due to bending} = \frac{1.275\,Pl}{d^3}$$

$$\text{Stress due to double shear} = \frac{P}{2 \times \text{Area of Pin}}$$

Now, assuming a crank pin for G.J.T.'s engine say 7 in. in diameter by 7½ in. long and his engine exhausting to atmosphere, with back pressure about 5 psig.

$P = (150-5) \times 0.7854 \times 20 = 45{,}550$ lb unbalanced pressure

$$\text{Stress due to bending action} = \frac{5.1\,Pl}{d^3} = \frac{5.1 \times 45{,}500 \times 7.5}{7 \times 7 \times 7} = 5081 \text{ psi}$$

$$\text{Stress due to shear} = \frac{P}{\text{area of pin}} = \frac{45{,}550}{0.7854 \times 7 \times 7} = 1184 \text{ psi}$$

Now assuming a wrist pin, say 4½ in. in diameter by 5 in. long of unsupported length in the crosshead:

$$\text{Stress due to bending} = \frac{1.275\,Pl}{d^3} = \frac{1.275 \times 45{,}550 \times 5}{4.5 \times 4.5 \times 4.5} = 3187 \text{ psi}$$

$$\text{Stress due to double shear} = \frac{P}{2 \times \text{area of pin}} = \frac{45{,}550}{2 \times 0.7854 \times 4.5 \times 4.5} = 1432 \text{ psi}$$

Vancouver, B. C. ERIC C. DEAN

Power Engineers' Digest

Includes abstract and digests of papers presented before various general meetings of A.S.M.E. Complete copies should be ordered by the numbers at the end of the article, when given, and they may be had for 25 cents each. Send your order direct to American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y.

Waste Felt Scrap Generates Nearly Cost-Free Steam

GENERATION of 15,000 to 20,000 lb per hr of "nearly cost-free" steam by a manufacturer of felt base floor coverings has been made possible through the burning of waste scrap, F. C. Messaros, chief engineer of the American Engineering Co., told The American Society of Mechanical Engineers at its 1950 annual meeting in New York in December.

Mr. Messaros described the refuse burner in operation at the Philadelphia plant of the Sloane-Blabon Corp. It is a furnace consisting of a primary and secondary unit, burning coal in one and waste in the other, the combined gases being conducted through a common boiler. He said he believed this to be the first furnace where asphalt-saturated felt scraps are burned as the refuse fuel in a two-stage furnace, particularly in conjunction with spreader stoker firing.

Within recent years more and more attention has been directed towards utilizing combustible waste for power generation. As the cost of basic fuels has increased, more methods have been devised for burning these cost-free wastes, at the same time getting rid of a costly disposal problem.

Many waste products have been burned. They include coal dust, coke breeze, black liquor, cork, jute and wood wastes, sawdust, bark, paper, spent hops, bagasse, cereal wastes, corn cobs and leather scrap. The author predicted that there will undoubtedly be a greater use of such substitute fuels in the future.

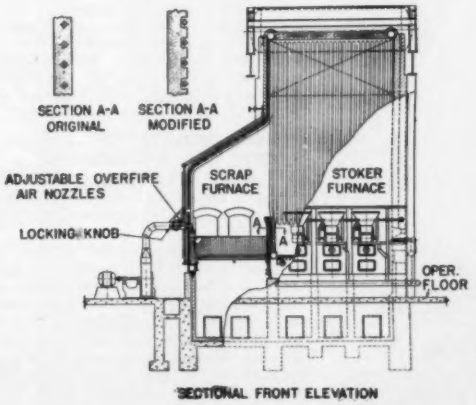
Felt Waste Makes Good Fuel

A study of the make-up of the scrap at Sloane-Blabon shows that its constituents favor its use as a fuel. In reality it is felt base, saturated with asphalt on which protective and decorative paint coatings have been applied. The usual felt base contains approximately 50 per cent wood pulp, 14 per cent rag stock and 36 per cent newsprint. Specially selected blown asphalt is used as the impregnating material.

The outstanding features of asphalt-saturated felt waste are its low moisture, high volatile and high calorific value. Its low moisture content eliminates the need for ignition arches commonly used in burning high-moisture waste. Its high-volatile content requires special attention, and adequate turbulence must be provided to obtain efficient, smoke-free combustion.

Two-Stage Furnace More Effective

During the post World War II period of modernization and expansion of the Sloane-Blabon plant, it was decided to replace the existing separately-hand-fired scrap burner with a two-stage furnace.



Sectional front elevation of steam generator at Sloane-Blabon Corp. with two-stage furnace for burning coal on spreader stoker and waste felt scrap by hand firing. Boiler is two-drum vertical type unit

Such an arrangement would be more effective, for initial gasification and partial combustion of the scrap would take place in the first stage, and combustion of these gases would be completed in the second stage. The gases of both scrap and coal would then enter the common boiler.

Moreover, if the secondary or coal furnace were mechanically charged and automatically controlled, swings in load could be easily handled. Furthermore, costly shut downs and light-offs would be prevented, for, if no scrap were available, coal alone would carry the load and, if scrap were available, the two could be fired simultaneously.

Spreader Stoker for Secondary Furnace

A spreader stoker is used, equipped with dump grates and with three chain conveyor type coal feeders. The chain feeder delivers coal to an overthrow rotor of spiral-type design which, due to its curvature, is designed to distribute coal evenly throughout the furnace, to handle coal high in moisture and permit low coal burning rates when burning scrap. The unit is equipped with cinder and fly ash reinjection equipment as well as overfire air nozzles.

After considerable experimentation, mechanical feeding was ruled out for the primary furnace because the preparation of the scrap proved to be too difficult and hazardous to personnel.

The primary or scrap furnace is approximately 8 ft 8 in. wide and 12 ft deep. The furnace is water cooled on side wall and roof. Front and rear walls are of refractory construction. The unit employs manually-operated dump grates having a projected grate area of 97 sq ft and furnace volume of 1250 cu ft.

Preheated primary air at 300 F is used under the scrap burner grate as well as under the coal burning grate with separate damper regulation to each. Partial separation of the scrap burner and stoker furnace is accomplished by a water-cooled curtain wall, refractory covered to a height of approximately 4 ft above the grate level.

Curtain wall tubes are widely spread to permit the scrap burner gases to pass into the stoker furnace without restriction. Due to physical conditions in the region of the boiler unit, the scrap is charged at the rear of the setting through two large openings each 32 in. square and equipped with vertical lift doors.

Savings Justified Capital Investment

It is estimated that at least 15,000 to 20,000 lb per hr of steam, representing 17,9000 lb to 23,800,000 Btu reclaimed per hour, can be and has been generated by burning scrap alone. The economic advantages of generating 15,000 to 20,000 lb per hr of nearly cost-free steam are ob-

vious. Needless to say, the savings in fuel consumption alone have more than justified the capital investment. Also deserving of comment is the saving in initial cost realized on a combined furnace of this type over two separate furnaces, each built for the burning of their respective fuels. —*Paper No. 50-A-63.*

SMOKE AND FLY-ASH

TECHNOLOGY is now available to practically eliminate smoke and handle most of the fly-ash problems in air-pollution. Hamnett P. Munger, in charge of air-pollution research at Battelle Memorial Institute, Columbus, Ohio, told the 1950 annual ASME meeting. Close coordination between public officers, industry and research organizations is required for the most rapid progress in solving this problem.

Only within the past five years have studies of methods for reducing air-pollution been intensified, due to public interest on a national scale. Several millions of dollars are spent annually for research in this field.

It is the public who will pay for the cleaner air that it breathes; much of the cost will be recovered by lower crop and property damage and better living conditions.

Plant by Plant Analysis

Each industrial plant problem must be analyzed individually to secure the most economical solution to the problem.

The same factors must be studied for a community or metropolitan area as for a single plant. Here the problem is made more complex by the many sources of contaminants and by the fact that the air is three dimensional. Many of the newer techniques are directed at solving this type of problem. Even in a community survey it is necessary after studying the over-all conditions, to work out the details of reducing air contaminants plant by plant.

Latest improvements in collecting equipment have been in the newly designed mechanical separators, both wet and dry, and the Venturi scrubber. In the Venturi scrubber, the water droplets are broken into a very fine mist. This mist is formed by the high velocity of the effluent gas, passing through the Venturi portion of the collector. These very small droplets wet and absorb very small particles by the Brownian movement in the air.

Greatest need of the present air-pollution control program is to find lower cost methods for removing the smaller particles from effluent gases.

Measurement of Dirt Fall

A new device has been developed at Battelle which determines the amounts of dirt fall while the wind is blowing in various directions. Placed in a heavily industrialized area, it is expected to be useful in locating the direction from which large quantities of dirt come.

Newer techniques of study make possible the determination of the concentration of air contaminants at various altitudes as well as at ground level.

Techniques using Kytoons, or kite-ballons, not only permit the measurement of wind velocity and direction up to 500 ft and higher, but also allow the sampling of gases and particulate matter at the same height. Meteorological observations at chimney-top level and higher are important, and may also be taken by this method.

A low-velocity wind tunnel has been used to investigate the part that building design, stack height, gas velocity and wind velocity play in controlling the path of the smoke from the stack.

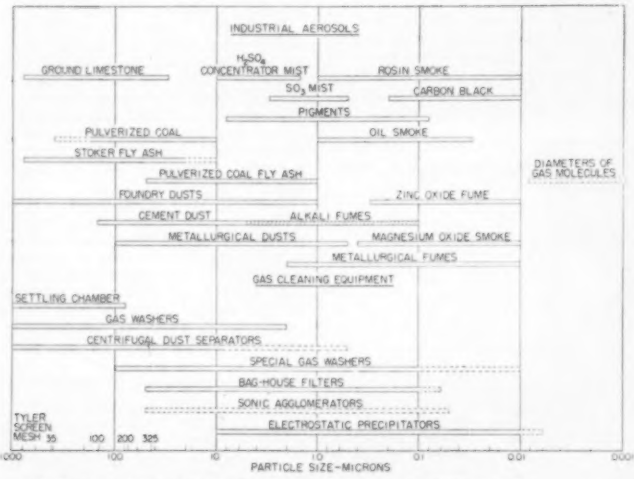


FIGURE 8. PARTICLE SIZE OF INDUSTRIAL AEROSOLS AND EQUIPMENT FOR CLEANING GASES

Fig. 1. Particle size of industrial aerosols and equipment for cleaning gases

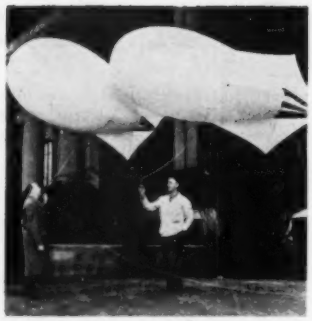


Fig. 2. Skyhooks—technical name Kytoons—for holding instruments up in the air to make measurements of gases, dust and so on

Most of the work in sampling airborne contaminants has been directed toward the determination of the amount and properties of aerosols present.

Among the newer developments has been an adaptation of the Venturi scrubber for collecting small amounts of airborne contaminants from large volumes of air. From these methods for sampling and determining the properties of aerosols, one may be selected which will be suitable for nearly any of the contaminants encountered in industry.

A Continuous Aerosol Analyzer

Equipment for continuously measuring both "light" and "dark" aerosol concentrations in the air is in the design stage. If there is a demand for such equipment, it could be developed rapidly.

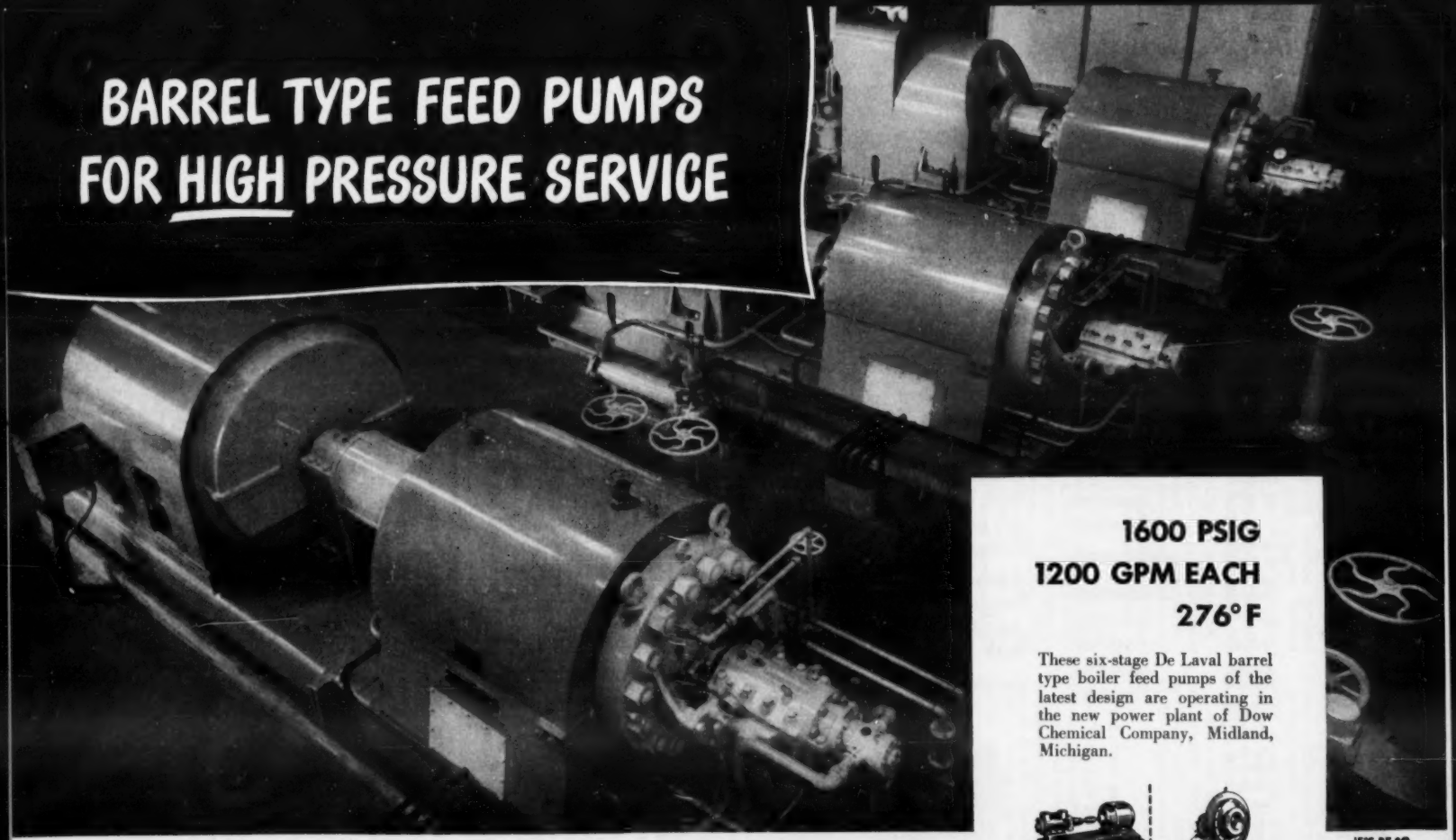
Using this continuous aerosol collector, it will be possible to obtain the variation of the total aerosols present throughout the day and night. It may also be possible to differentiate between the "dark-colored" aerosols, which are tarry or carbonaceous particles, and "light-colored" aerosols, which represent fly-ash and similar materials. With the continuous collector, it may be also possible to correlate wind direction with aerosol concentration.

"SWEAT-COOLING" OF ROCKET AND JET ENGINES

"SWEAT-COOLED" rocket and jet engines capable of higher speeds than ever may be in the offing for the U. S.

Rocket and jet engines are being pushed to such high capacity these days that one of the big problems is maintaining surfaces cool enough so that the metals will not be heat-damaged. "Hotter" engines are desirable however, because higher gas temperatures mean greater speeds and better fuel efficiency in jet en-

BARREL TYPE FEED PUMPS FOR HIGH PRESSURE SERVICE



1600 PSIG
1200 GPM EACH
276° F

These six-stage De Laval barrel type boiler feed pumps of the latest design are operating in the new power plant of Dow Chemical Company, Midland, Michigan.

1525-BF-9B

DE LAVAL STEAM TURBINE CO., TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

DE LAVAL

gines, Allan P. Colburn, provost of the University of Delaware, told the ASME at its 1950 annual meeting.

Many cooling methods are under consideration and one of the means being studied is "sweat-cooling." In sweat-cooling liquid is forced through the metal, either through transverse holes or porous parts of the metal. The liquid then vaporizes on the hot surface of the metal.

Calculation of heat transmission involves diffusion of the vaporized liquid counter to the direction of the conduction of heat.

Alternate Cooling Methods

The effect of the vaporized liquid on the surface friction also involves an important factor to be studied.

Provost Colburn cited an alternative cooling means. This is by use of a liquid used well below its boiling point. Since the metal surface may be well above the boiling point of the coolant, local boiling is involved.

A great deal of work is under way at the National Advisory Committee for Aeronautics on heat transmission to turbine blades and means for cooling them. They may be cooled by internal coolants as air, water, or other liquids, but problems of superimposed free and forced convections are encountered.

Another possibility for securing higher fuel efficiency is by the use of very efficient heat exchangers. Much work is under way in this direction.

ECONOMIC, SOCIAL TRENDS INTENSIFY IMPORTANCE OF COAL LOGISTICS

The importance of the coal handling system in power plant design has been intensified by economic and social trends in a large measure, and by progress in over-all plant design, Frank W. Lovett, engineer, Power Plant Equipment, Link-Belt Co., declared before the 1950 annual meeting of the American Society of Mechanical Engineers in New York.

Among today's problems are: handling coal at larger hourly rates to serve the greater generating capacity of individual stations; the currently poorer grades of coal; providing larger reserve coal storage because of the uncertainties of the coal supply; higher labor costs and the difficulty of obtaining men at any price; effective means of controlling dust to provide better housekeeping.

It is important also to plan the coal handling system in the earliest studies for a new power plant. In fact, even the site for a large central station cannot be selected with assurance until the logistics of handling coal are determined. Consider, too, that coal handling systems for today's central stations cost between $3.00 and $5.00 per kw of installed capacity.

Mr. Lovett covered all phases of coal handling equipment from unloading station to power plant bunker and furnace, and to and from reserve storage pile.

CONSERVATION MEASURES TO AID MOBILIZATION

As part of an all-out drive for conservation in the field of mobilization planning, the National Security Resources Board will re-create a Conservation Coordinating Committee such as operated during the last war.

Howard C. Coonley, chief conservation planning specialist for the NSRB, told the 1950 Annual ASME meeting that W. Stuart Symington, NSRB chairman, agreed to the creation of the conservation committee under the chairmanship of the NSRB several weeks ago. The role of the committee will be to initiate and develop broad unified programs of conservation in the mobilization effort.

The committee will include representation from all three divisions of the Department of Defense, the Munitions Board, the National Production Authority and other Government departments and agencies that have a major concern with materials, facilities, manpower and production— a total of 19 departments and agencies.

Need Enthusiastic Approval

Setting up of this committee was the most important activity that will be undertaken by the National Security Resources Board in the vital field of conservation. Conservation is not an American characteristic; we lack a spirit of thrift. However, it should not require a war or even a threat of war to make us aware of the necessity to save. Our people have ingenuity, adaptability and driving power, but we are not by nature accustomed to make much out of little to see how far we can stretch the cloth which is within easy reach.

Important Ingredient

In the present crisis, said Mr. Coonley, conservation is the ingredient that will expand the output of our mills and our machinery, that urgently important additional amount which is needed to take care of civilian as well as military requirements, and thereby safeguard our republic and assure the survival of the democratic nations of the world, whether our destiny be the terrors of another war or the blessings of long years of peace.

Conservation in mobilization planning may be divided into six broad categories, he said. They are: standardization, specifications and simplification; measures to determine and safeguard supplies of critical materials; development of substitutes wherever necessary and possible; salvage and savings at the source; cataloging of supplies under a system of standard identification to avoid duplication and waste; international cooperation in conservation measures.

The NSRB is giving "every encouragement" to the Standards Agency of the Munitions Board in its work of reviewing several of their standards for drawings and drafting room practices and planning an expansion of these standards.

RAILROAD FUEL CONSUMPTION REDUCED 16.4% WITH DOUBLE-SCREENED COAL AND BURNING OF CINDERS

Substantial savings in railroad fuel consumption can be effected by the use of double-screened coal and the burning of locomotive cinders, but when both methods are used in combination the reduction in coal consumption may be as high as 16.4 per cent. This was reported to the 1950 annual meeting of the ASME.

Since the application of the stoker to the coal-fired steam locomotive, the firing rates on the locomotive have been increased to values far in excess of the rates at which coal is generally burned. In a paper on the collection and burning of locomotive cinders, three fuel engineers of the Battelle Memorial Institute, Columbus, Ohio, said these high rates of firing have resulted in high rates of cinder emission from the stack which, when measured in terms of heat lost, may amount to as much as 40 per cent of the heat contained in the coal fired. Both from the economic and the nuisance viewpoints, this emission of solids is undesirable, the authors declared.

They were Bertrand A. Landry, supervisor, John M. Allen, research engineer, and Elmer J. Boer, assistant supervisor, all of Battelle Memorial Institute.

Stack Emission Reduced

Standing tests with a Norfolk and Western Railway locomotive, equipped with a cinder collector designed at Battelle, were conducted to determine the percentage collected and the percentage burned when returned to the firebox. Results indicated that an average of 80 per cent of the cinders are separated from the flue gases and about half of the reinjected cinders are burned. The greater part of these cinders burn in the bed, releasing their ash on the grate.

At the highest rate of burning, fuel consumption was reduced 10.5 per cent and the stack emission was reduced 55 per cent by collection and reinjection of cinders from the resultant size coal. Substitution of a double-screened coal for the resultant size gave, with collection and reinjection, an over-all reduction in fuel consumption of 16.4 per cent and a reduction in stack emission of 65 per cent.

Why Pay for Corrosion...

"Prevention is Cheaper"

ALLIS-CHALMERS
No. 160 SERIES
Corrosion Inhibitor

WHEN ECONOMIC FACTORS fail to justify more comprehensive water treatment, protect your steam-condensate system from CO_2 corrosion with Allis-Chalmers No. 160 Series Corrosion Inhibitor. This material, designed to vaporize and condense with the steam, neutralizes condensate *where* and *when* it forms — whether in the low pressure turbine stages or in the steam and condensate piping.

Ammonia, released from some corrosion inhibitors and actually mixed into others, *is not present* in No. 160 treatment. For this reason it may be fed into systems with brass and bronze fittings without fear of expensive deterioration. Relatively inert chemically, it permits feeding with phosphate, sulfite or other supplementary materials at any point in the system.

No. 160 Series Corrosion Inhibitor may be the answer to your problem if deterioration of your steam-condensate system or steam using equipment is high. Corrosion testing equipment is available through Allis-Chalmers for an accurate check on deterioration "before and after" treatment. Find out for yourself how much protection — or a lack of it — will cost you.

For a factual discussion of the new Allis-Chalmers No. 160 Series Corrosion Inhibitor, write for bulletin number 25X7582 or contact your nearby Allis-Chalmers Office. Representatives there will arrange to have your problem brought before an Allis-Chalmers water conditioning specialist.

Allis-Chalmers
Milwaukee 1, Wis.

Gentlemen:
Please send me bulletin 25X7582.

Name .....

Title .....

Company .....

Address .....

City ..... State .....

A-3279

ALLIS-CHALMERS

Water Conditioning

✓ EQUIPMENT ✓ CHEMICALS ✓ SERVICE

New ENGINEERING BOOKS

Economics of Fuel Gas from Coal, by Battelle Memorial Institute, John F. Foster and Richard J. Lund, Editors. First Edition; 289 pages; size 6¼ by 9¼ in.; cloth, published by the McGraw-Hill Book Company, 330 W. 42nd Street, New York 18, N. Y.; 1950; price $5.00.

This book reports in detail a study and an intensive survey of the production of fuel gas from coal, covering both the technical and cost factors concerned, together with comparative cost data on other fuels, such as natural gas. This study was carried out by Battelle Memorial Institute as an assignment from the Gasification and Carbonization Committee of the Technical Advisory Board of Bituminous Coal Research, Inc., the research agency of the bituminous coal industry. The primary objective of the survey was to provide background information that would be useful in appraising proposals for sponsorship of gasification research by BCR.

Some people may be a bit surprised at the conclusions the authors draw from this survey but they certainly will not surprise most engineers. In Chapter 15 of the book, a long and detailed analysis summarizing all the factors involved, the authors conclude "that fuel gas produced at the mines by the cheapest known methods and piped to consuming centers cannot compete with natural gas piped distances four or even six times as far. This conclusion is based on a review of technical and economic factors relating to new coal-gasifying techniques and to the competitive fuel picture. Furthermore, it appears likely that this situation will prevail for some time. The spread between present costs of natural gas in large consuming centers and estimated costs of fuel gas from coal is now great. Natural-gas prices at the city gate would have to double at least before the competitive level would be reached. Moreover, there appears to be little chance that gasification of coal can compete with either heavy or light fuel oil at 1948 prices."

"On the other hand, producer gas may be on the threshold of a comeback. In the first place, it cost less in 1948 than fuel oil—heavy or light. In the second place, it assures a steady supply of fuel gas. This is important in times when interruptions of natural gas during severe winter weather must be expected and the long-term supply of fuel oil is uncertain."

These conclusions are all explained and analyzed in considerable detail with comments on costs of various fuels, costs of transportation, manufactured gas versus other fuels, a discussion of the interest of the coal industry in gasification for pipeline transportation, and details of the research by others in this same field.

In order to reach these conclusions, the authors begin, in Part I of the book, with discussions of types and characteristics of fuel gases, production and use of manufactured gas and producer gas. This is followed in Chapter 4 by a discussion of the problems of the manufactured gas utility, such as the use pattern of manufactured gas, the various kinds of gas manufactured, cost of raw fuel, the problem of peak loads.

Chapter 5 treats the subject of water gas in detail, including the various German gasification processes.

Chapter 6 discusses pipeline gas; Chapter 7, underground gasification of coal; Chapter 8, production of oxygen; and Chapter 9, current research on synthetic fuel.

In Part II of the book on economic aspects of fuels, we find Chapter 10 devoted to petroleum—supply, demand and prices; Chapter 11, natural gas—supply, demand and prices; Chapter 12, coal prices—past, present and future; Chapter 13, cost of transporting energy; Chapter 14, nuclear energy as a source of electrical power; and Chapter 15, summary and conclusions referred to above. The data in the various chapters are presented by various authors in collaboration with the two principal editors, and the conclusions reached and opinions expressed are necessarily theirs. They are all members of the Battelle staff.

To sum up, the book contains a great deal of information on fuel costs and costs of transporting fuel that is not available elsewhere and the book should be especially valuable to any reader interested in analysis of future fuel costs in specific situations. Since the power engineer so frequently has to answer the question "Will it pay?" he will find this book a mine of information on his present and future fuel situation.

• • •

Steam Turbines, by Edwin F. Church, Jr. Third Edition; 531 pages; illustrated; size 6¼ by 9¼ in.; cloth; published by McGraw-Hill Book Company, 330 W. 42nd St., New York 18, N. Y.; 1950, price $6.00.

This is the third edition of a standard text on this subject and here too, as in so many new editions, the developments of recent years have necessitated an almost complete rewriting of the original text. In this case, many of the drawings and photographs in earlier editions represented practice now obsolete and these have been replaced with examples of modern design and construction.

Among the topic additions and enlargements in the new text, are a more general treatment of steam turbine blading theory and performance with various degrees of reaction; variations of fluid flow through nozzles and blades at different radii; twisted blades; elementary aerodynamic theory and its application to the design of turbine parts; effects of sonic or near-sonic velocities on the flow in turbines; vibrations; forms taken by turbines due to differences in steam and exhaust conditions; magnitude of output and use applications; forms taken by turbine structural elements and materials used to meet the special requirements of high steam pressure and high temperature; high speed of rotation and large capacity; forms of governors suitable for turbines of various types and sizes, and performance data covering a wide range of sizes and types of turbines.

Because it is difficult for students to visit turbine manufacturing plants to study details of design and construction, the author has included a large number of drawings and photographs showing these details. This book is designed as an intermediate textbook for those who have had preparation in thermodynamics and mechanics equivalent to that of junior or senior students in engineering colleges.

The subject is covered under the following chapter headings: 1—Types and Characteristics; 2—Steam-Turbine Cycles; 3—Flow of Steam in Nozzles; 4—Nozzle proportions and tests; 5—Impulse-Blading Velocity Diagrams; 6—Impulse-Blading Proportions; 7—Reaction-Blading Velocity Diagrams and Blading Proportions; 8—Effects of Use, Capacity, Speed and Steam Conditions on the Arrangement of Turbine Elements; 9—Aerodynamic Considerations; 10—Elements of Supersonic Flow; 11—Vibrations; 12—Structural Elements, Materials and Stresses; 13—Losses; 14—Efficiency, Reheat Factor and Condition Line; 15—Output Variation and Governing; 16—Turbine Performance; 17—Design.

At the end of the book are given a number of problems referring to each of the chapters, a list of references for each chapter and a good index. For those who wish to study blading design, the chapters devoted to these subjects are well illustrated with velocity diagrams and the mathematics for calculating blading is given in detail.

• • •

Fuels and Combustion Handbook, Edited by Allen J. Johnson and George H. Auth. First Edition; 915 pages; size 6¼ by 9¼ in.; flexible binding; published by McGraw-Hill Book Co., 330 W. 42nd St., New York 18, N. Y.; 1950; price $12.50.

This volume was, in effect, compiled from some 450 major references with the permission and co-operation of their authors and copyright owners. Every effort was made to use the most recent articles available with full consideration for their value. As a result, over 50 per cent of the material presented here is less than 5 years old, and over 80 per cent is less than 10 years old. Accordingly, these data may be assumed to represent current accepted practice. The objective of this handbook is to present comprehensive factual data over the full range of commercial fuels for study by practical engineers, students of fuel and all others having an interest in the selection or use of fuels or fuel utilization equipment of any type.

Section 1 of the book takes up Solid Fuels, their sources and reserve, their general characteristics, details of Pennsylvania anthracite and other anthracite coals; bituminous, subbituminous and lignite; peat, wood and agricultural wastes, and manufactured solid fuels, cokes and briquettes.

Section 2 deals with Liquid and Gaseous Fuels and Miscellaneous Sources of Heat and Power. It discusses petroleum, colloidal and shale fuels and synthetic fuels, gaseous fuels and miscellaneous sources such as electricity, water power, wave power, wind power, solar heat, thermal springs, thermit and atomic energy.

Section 3 deals with combustion of fuels, calculation of heat balances, draft and chimneys and smoke and other combustion rejects, including slag.

Section 4, one of the most important in the book, deals with the selection of a fuel, such as the design approach for a fuel burning plant, factors in the purchase of coal, coal specifications, cost of fuel and electricity in various industries.

Section 5 covers Preparation of Coal for Utilization, such as chemical treatment of coal and coke, and coal dewatering and drying, also the crushing and pulverization of coal.

Section 6 covers Fuel-Handling Methods, including handling and storing of solid fuels and liquid and gaseous fuels. In this chapter, as in the others, considerable emphasis is placed on the methods suitable for small as well as large plants.

Section 7 covers heat transfer and insulation, boilers and steam generators, fundamentals of furnace design, methods of firing solid fuels, firing liquid and gaseous fuels, some non-steam-making uses of fuel.

Section 8 is a general section on boiler measurements and tests.

Throughout the book the attempt is made to deal with all the foregoing subjects in the most practical manner as they concern the practicing engineer.

By bringing together in one volume a great deal of the recent practical data on fuel burning, the authors have performed a distinct service to the field, it seems to us. For example, we note they include some little known tables on furnace volumes, presented a couple of years ago before the Midwest Power Conference, that have appeared only in the Proceedings of that conference. Specific data on types of equipment available for burning various fuels are tabulated in a practical way. Performance curves of hrt boilers, a widely used type, should prove extremely useful and similar curves are given for three-pass water-leg boilers, three-drum boilers and other types, showing boiler rating in per cent, exit gas temperature and draft loss. There are interesting coal selection charts for stationary steam generators, nomographic methods of computing heat balances, and complete data on all types of fuels. There is an absolute minimum of theory and mathematics and the book is very well indexed.

• • •

The Integrated Power System, by Philip Sporn. First Edition, 157 pages, size 5¾ by 8¼ in.; cloth; published by the McGraw-Hill Book Co., Inc., 330 Fourth Avenue, New York, N. Y.; 1950; price $4.00.

This little book by the president of the American Gas and Electric Service Corp. promotes what he calls the integrated power system as the basic mechanism for electrical power supply. During the past several decades, there has grown a progressive awareness of the role of electrification and of electric power in advancing the welfare of modern society. At the same time there has developed a much clearer understanding of the true function of electrification and electric power in any modern, social, economic system.

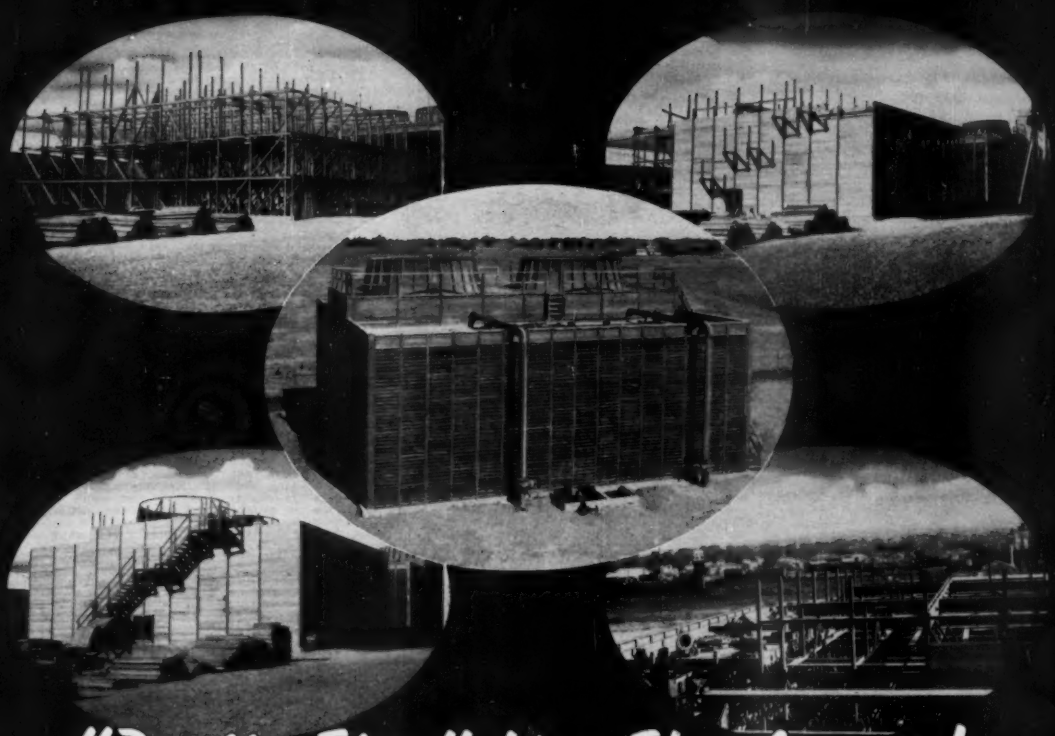
In this book Mr. Sporn discusses the fundamental social and economic objectives of an integrated power system, and also the technical basis and requirements for such a system. Mr. Sporn's book is the outgrowth of more than 30 years in the study, analysis, development, building and operation of power systems. It is intended to present the basic principles, the components, the economic advantages, disadvantages and limitations of the integrated power system as a basic mechanism for power supply. The validity and soundness of Mr. Sporn's proposals is brilliantly reflected in his summary concerning the operation of his own system as an integrated system. By the reduction of losses and by the increased efficiency of the stations and equipment, Mr. Sporn shows that compared to the national average, the American Gas and Electric Co. will save 2,650,000 tons of coal in 1951.

The book should find interest among technical students and power system executives and engineers throughout the entire electric power industry.

• • •

Capacitors for Industry, by W. C. Bloomquist, C. R. Craig, R. M. Partington and R. C. Wilson. First Edition; 246 pages; size 6 by 9¼ in.; cloth; published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York, N. Y.; 1950; price $4.50.

There are two things engineers never seem to get tired of discussing—one of these is entropy and the other power factor. Untold thousands of words have



"Double-Flow" Was The Answer!

A power plant needed a water cooling tower for steam condensing. A Conventional Mechanical Draft Tower could handle the heat load—but that type of tower fell short when they considered operating efficiency.

The MARLEY "DOUBLE-FLOW" cooling tower met all their exacting requirements because its exclusive design offers maximum efficiency by accelerating the effective rate of heat transfer by means of perfected air-water flow. It effects maximum savings over a longer service life—in water, power, cleaning and all other operating costs. Its water distribution system is entirely external with all parts accessible for easy, frequent checking and cleaning.

For these reasons a two-cell MARLEY "DOUBLE-FLOW" cooling tower was selected to meet the initial water cooling requirements of this electric power plant.

When they learned, by first hand knowledge, of the many other quality features such as rugged construction . . . mechanical equipment designed and built for cooling tower use exclusively . . . two independent cooling cells for each fan . . . nail-less redwood filling . . . more drift eliminator area . . . and performance as guaranteed . . . they were delighted they had selected MARLEY "DOUBLE-FLOW".

Naturally, MARLEY was called in to furnish another "DOUBLE-FLOW" cooling tower when they enlarged their facilities.

Every power plant has its own cooling problems. So does every oil refinery and chemical plant. In fact, every industry has cooling problems. Your problem may be entirely different. And, it takes experienced application engineers to know which cooling tower or DRICOOLER will serve you best.

Talk over your cooling problems with MARLEY . . . let us help you. MARLEY engineering service offices are located in 42 principal cities. Our services for consulting or estimating are available without obligation.

MAIL THIS COUPON TODAY PE-2

The Marley Company, Inc., Kansas City 15, Kansas

☐ I'd like to know more about DOUBLE-FLOW Cooling Towers. Please send FREE Bulletin DF-50.

☐ Have Engineer call, at no obligation to us, to discuss our water cooling needs.

Name _____ Title _____

Company Name _____

Address _____

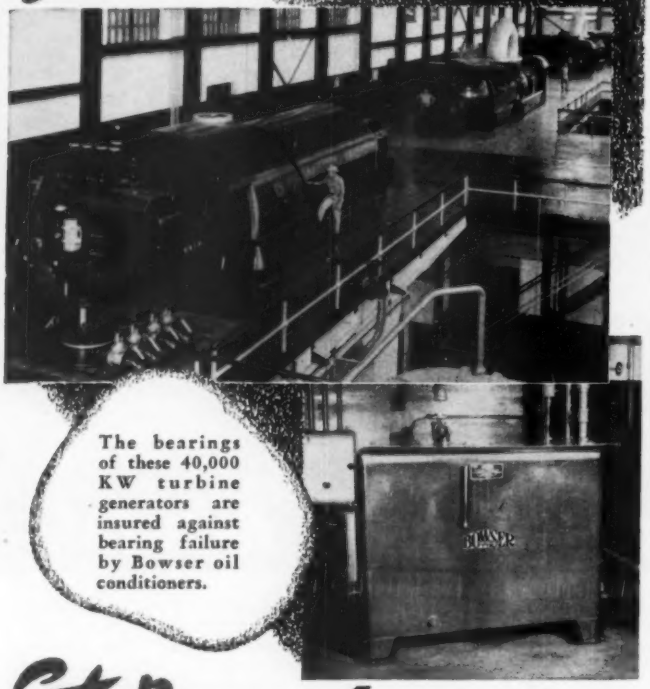
City _____ Zone _____ State _____

COOLING TOWERS—DRICOOLERS

MARLEY

Double-Flow Vairflo DriCooler Natural Draft Counter-Flow Aquatower Spray Nozzles

Longer life for Turbine Bearings



The bearings of these 40,000 KW turbine generators are insured against bearing failure by Bowser oil conditioners.

Stop THESE 6 ENEMIES OF TURBINE OIL NOW....

1. Turbulence
2. Air Entrainment
3. Moisture Contact
4. Heat
5. Metallic Contact
6. Removal of Inhibitors

When turbine bearings "stay-on-the-job," costly shutdowns are avoided and less standby equipment is required.

• • •

Write today for your copy of this new bulletin on the improved Bowser method for conditioning turbine oils.

BOWSER, INC., 1351 Creighton Avenue, Fort Wayne 2, Ind.

LIQUID CONTROL SPECIALISTS SINCE 1885

been written on both subjects, innumerable papers and books have been published, but there always seems room for one more and for another point of view.

This is a book about power factor, even though it does not have the term in the title, and it is a very excellent book on power factor. In fact, for the practical man's money, it is one of the best that has come to our attention in a long time. The reason it is good is because it contains numbers. It tells exactly how you go about this business of improving power factor by the installation of capacitors, or static condensers, as they used to be called, by means of worked-out examples.

Written by four engineers, two connected with the General Electric Co., and the others with the Trumbull Electric Mfg. Co., who have spent a considerable portion of their lives in the design and installation of capacitors, they don't have to call on their imagination for their subject matter. They have had plenty of experience. They tell you in the beginning why capacitors are used, basically, of course, to reduce power costs. Then they go on to tell you why 2 plus 2 does not make 4. It doesn't!

What is power factor? They tell you that also. Simply, effectively, without much talk about wattless currents. Their approach to the subject is based on the simple fact that there are two types of current in a-c circuits — power producing current and magnetizing current. Kilovars and kilowatts are explained simply and again in terms of numbers—actual values, actual examples.

Before you get to Chapter 3 you know how to improve power factor. You have been shown how to calculate capacitor values and you have been shown how these capacitors are actually installed.

From there on you get into discussions of instruments for power factor studies, factors governing the location of capacitors, voltage improvement, power system losses, power factor rate studies, application of capacitors to motors and generators, and many other things among which are automatic control equipment, a good chapter on specifications for capacitor equipments and ending with a chapter on capacitor installation and maintenance.

The book is exceptionally well-designed, contains all the necessary graphs and tabulations for making calculations, and at the end there is an excellent bibliography of articles on the subject of capacitors and power factor correction. We cannot recommend this book too highly.

• • •

The Primeval Atom, by Canon Georges Lemaitre. First Edition, 186 pages, size 5¼ by 7¾ in.; cloth; published by D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York, N. Y.; 1950; price $3.00.

This fascinating book by Canon Lemaitre is worthy of attention and study by all who are or have been interested in cosmogonic hypotheses. Most of us in the business of producing and distributing power are kept busy with the practical problems involved in the manifestation of the second law of thermodynamics in our engines and turbines. But it is good for our souls, or whatever ails us at times, to give a little thought to matters which, even if they must remain forever remote from our everyday lives, nevertheless offer the most fascinating field of speculation one can ever hope to indulge in. The second law of thermodynamics itself, of course, is one phase of this study.

Medieval philosophers used to argue at length as to the number of angels that could balance on the point of a needle. Satisfying as their speculations may have been to themselves, they were based on little that could be called tangible. The speculations of the modern cosmologists at least are more worthwhile because their hypotheses are based on the findings of physicists and astrophysicists who, armed with their great telescopes and spectroscopes, penetrate the utmost depths of space, as well as the infinitesimally small confines of the atom.

A generation ago the theories of Eddington, Jeans, Einstein, De Sitter, Lemaitre and others became well-known, if not always well-understood, elements in the vocabulary of the intelligent layman. Theories of the structure of the universe were talked about to the extent that dogmatism in this field more or less disappeared. People were ready to consider almost anything concerning the structure or mechanism of the universe, even if the complexity of the various hypotheses made it impossible for them to crystallize their thoughts on the subject.

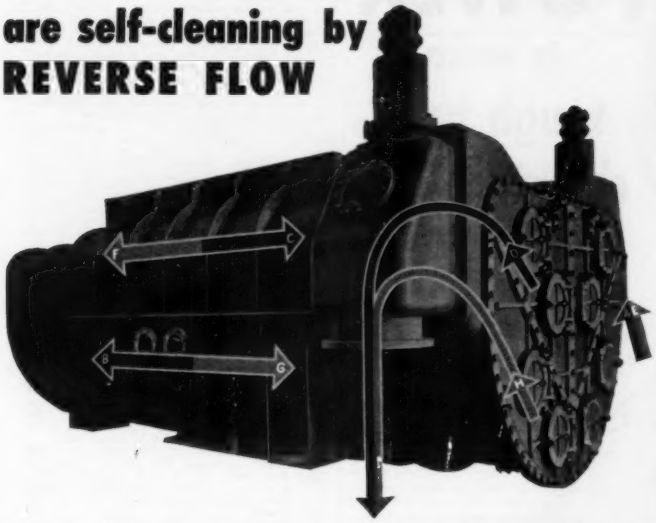
Today, with a much greater store of material knowledge at our command, knowledge which has emanated from the observatories and laboratories in an ever-

NOTES for the Power Engineer

C. H. Wheeler OF PHILADELPHIA

STEAM CONDENSERS—STEAM JET EJECTORS—COOLING TOWERS—VACUUM REFRIGERATION—HIGH VACUUM PROCESS EQUIPMENT—MICRO-PARTICLE REDUCTION MILLS—MARINE CONDENSERS & EJECTORS—DECK MACHINERY

C. H. Wheeler CONDENSERS are self-cleaning by REVERSE FLOW



End Downtime for Cleaning Maintain Constant Full Load

Now you can end your troubles with clogged tube sheets. No longer need you shut down a steam condenser while a conglomerate of refuse—vegetable, animal and mineral—is laboriously removed by slow hand methods.

C. H. Wheeler has developed a simplified method for *reversing* the flow of cooling water in either single or divided water box condenser designs. Rapid reversal of cooling water flow effects a sudden change in temperature which shocks and dislodges marine growth. The physical force of the water flushes this and all other debris, including sand and muck, down the discharge.

The self-cleaning reverse flow is accomplished in new C. H. Wheeler condensers by built-in valves or sluice gates. A push button performs the flow-reversing operation. What formerly took hours is now accomplished in a matter of minutes with no interruption in load.

If you don't need a *new*, integrally built, Self-Cleaning Condenser, C. H. Wheeler can apply the Reverse-Flow principle to other steam condenser installations by means of external piping and four-way valves. Your correspondence is invited. C. H. Wheeler is "Ahead in Condenser Development."

STEEL SHELL TUBEJET AIR EJECTORS MORE RELIABLE . . . SAVE SPACE

Engineers' fears of porous castings have led many to specify separate inter-after condensers with air ejectors. These fears are now totally dispelled with the new C.H. Wheeler Steel Shell Tubejet Air Ejectors. Designed originally to attain compactness for marine installations, thousands of these ejectors rendered outstanding service in World War II. This streamlined version of the older design effects considerable savings in space and weight. They are being widely adopted for stationary power plant use. Available with either single or multiple element, two-stage type with combined surface inter-after condenser. The coupon will bring you Specification 88, just released. It shows preferred method of piping to control hotwell level in main condenser.

THIS NEW CATALOG WILL BRING YOUR CONDENSER INFORMATION UP-TO-DATE

C. H. Wheeler Mfg. Co.,
1802 Sedgley Ave., Philadelphia 32, Pa.

Name .....

Department .....

Company .....

Address .....

Please mail me file material on C. H. Wheeler

☐ Self-Cleaning Condensers ☐ Tubejets (Specification 88)

C. H. WHEELER MANUFACTURING CO., 1802 SEDGLEY AVE., PHILADELPHIA 32, PA.

REPRESENTATIVES IN MOST PRINCIPAL CITIES

ROTOJET®

has the POWER to make tough tube cleaning jobs EASY

Power is the stuff that makes the new ROTOJET stand out from all other tube cleaners. It makes tough jobs ridiculously easy. Uses less air, too. Get a powerful, rugged ROTOJET, and no other cleaner will ever satisfy you. Air or water-driven models for practically any size straight or curved tubes.

ROTOJET Air-driven Motor Model 525 with swing-frame head and universal joint for 2⅛" to 3" I.D. curved tubes.

ELLIOTT COMPANY-ROTO DIVISION

147 Sussex Avenue Newark 1, N. J.

increasing stream for a quarter of a century, we are in a much better position to evaluate cosmological hypotheses than we were 25 years ago. Nuclear physics, a vastly better understanding of quantum theory, coupled with data from the great astronomical observatories, have supplied us with basic philosophical material undreamed of in the 1920's.

Canon Georges Lemaitre is an old hand in this field. As Professor at the University of Louvain, his writings have dominated cosmological literature for several decades. This latest work from his pen, therefore, must not be taken lightly. The Primeval Atom is a classic of theoretical science; it presents a hypotheses that will influence theories of space for a long time to come since it combines cosmic rays, atoms, worlds and stars and the puzzle of quantum physics in such a way that in the end they converge into a theory of brilliant and rewarding interest.

On the whole, this book, which is small as books go, is very understandable. Some of the concepts of the geometry of closed elliptical space will not be found easy for the non-mathematical reader but they can be accepted at face value and then the reader can go on to the interesting conclusion which Canon Lemaitre draws. Lemaitre's book, coming as it does almost at the same time as Littleton and Hoyle's work in England, presents contrasting points of view compared with those of the English cosmologists, yet the hypotheses have many factors in common.

The strange thing about Lemaitre's concept is that our universe began as a single atom, The Primeval Atom. As he puts it, thermodynamic principles from the point of view of quantum theory, may be stated as follows: 1. Energy of constant total amount is distributed in distinct quanta. 2. The number of distinct quanta is ever increasing. If we go back in the course of time, we must find fewer and fewer quanta until we find all the energy of the universe packed in a few or even in a unique quantum.

In all atomic processes, the notions of space and time are no more than statistical notions. They fade out when applied to individual phenomena involving but a small number of quanta. If the world began with a single quantum, the notions of space and time would altogether fail to have any meaning at the beginning. They would only begin to have a sensible meaning when the original quantum had been divided into a sufficient number of quanta. If this suggestion is correct, the beginning of the world happened a little before the beginning of space and time.

With this interesting beginning, Lemaitre carries you through the entire course of time and ends up with a definite figure for the radius of space. This, at the present time, amounts to about ten billion light years.

COAL ANALYSES

(Continued from page 73)

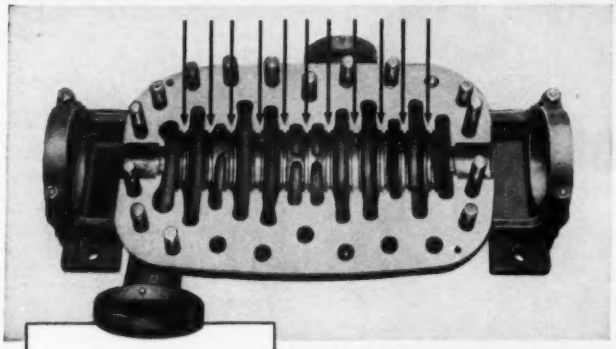
based upon the presentation of the vendor.

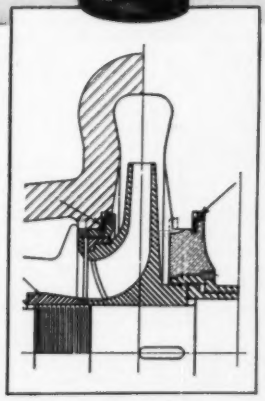
In order to illustrate the need for care in the selection of coals by the user, Fig. 7 is offered to show the annual depreciation of coal heat values and the corresponding increase in costs per million Btu received at a Dayton plant.

Up until 1942 the annual average heat content of the coal was about 13,670 Btu per lb as received. From then on the annual average dropped each year to about 12,700 Btu for 1949. These analyses represent composite bunker samples, in which individual sources are intermingled and unidentified. The enforced purchase of coal from many sources during this emergency period probably caused much of this drop in quality. Carelessness in mine loading by many sources during this period of great demand undoubtedly lowered the quality of many cars of coal. The quality of coal in shipments from high grade reliable sources dropped about 700 Btu com-

IN YOUR BOILER FEED PUMPING...

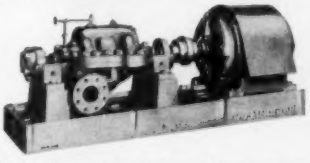
Get **HIGH** *reliability at* **MEDIUM** *pressure with* **LOW** *maintenance cost*





Lower casing half of a Worthington 6-Stage Type UR Centrifugal Voiute Pump. Arrows point to joints protected by Worthington Elastic Seal Rings.

Worthington Elastic Seal Ring construction (solid black areas) in a Type UX Pump. Flexible and resilient, the Elastic Seal Ring assures initial seating, makes joints liquid-tight, eliminates a common cause of pressure loss.



This Worthington Type UQ Pump incorporates the Worthington Elastic Seal Ring, latest improvement in mechanical design.

WORTHINGTON

WORTHINGTON PUMPS, TYPES UQ AND UR, ARE TOP PERFORMERS AT PRESSURES UP TO 950 PSI

In power plants throughout the world Worthington Centrifugal Pumps, Types UQ and UR, have proved themselves the most modern small-capacity boiler feed pumps in the medium pressure range. Correct in every mechanical and hydraulic detail, they feature:

- **Balanced design . . .**
- **No stuffing box trouble . . .**
- **Freedom from interstage leakage . . .**
- **Low Maintenance Cost**

Built for long, trouble-free service, these multi-stage volute-type pumps are by far the most dependable and economical for your boiler feed jobs at pressures up to 950 psi.

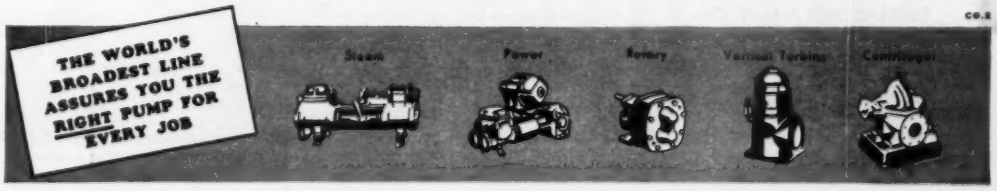
There's A Worthington Pump For *Every* Pressure Range

from 100 psi to 3000 psi and all outstanding in their class. In this most complete line you're sure to find exactly the right pumps for your own boiler feed requirements, large or small. For further proof that *there's more worth in Worthington*, contact our nearest District Office or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

MEMBER

co.2

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB



These EVERLASTING advantages give better service from

Fig. 4001/6561. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Angle Blowing Valve.

BOILER BLOW-OFF VALVES

When you install an EVERLASTING Duplex Blow-Off Unit, you'll find that its many superiorities speak for themselves.

The sealing valve at the left is the EVERLASTING design that has been famous for more than 40 years . . . the valve with the drop-tight seal that actually improves with use because of its self-lapping action each time the valve is opened or closed . . . the valve that can't stick or jam because of its non-wedge design . . . the valve that opens in less than a quarter turn to provide unimpeded straight-through blow.

The blowing valve at the right is the equally famous EVERLASTING Angle or "Y" Valve, specially designed and equipped to withstand repeated blow-off shocks, erosion and corrosion, and without pockets that might trap and hold solids.

Each of these valves . . . and all the other EVERLASTING Boiler Blow-Off valve types, fully meet ASME code requirements . . . assurance that they are properly designed and amply strong for the service.

Write for descriptive bulletin

EVERLASTING VALVE CO.
49 Fisk Street, Jersey City 5, N. J.

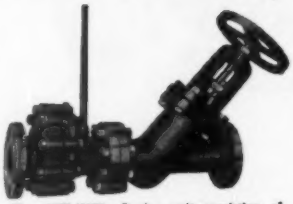


Fig. 4001/6571. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Y Blowing Valve.

Fig. 6571/6561. Duplex unit consisting of Y Sealing Valve and Angle Blowing Valve.

Fig. 6561/6571. Duplex unit consisting of Angle Sealing Valve and Y Blowing Valve.

Everlasting Valves

TRADE MARK "EVERLASTING" REG. U.S. PAT. OFF. EV-348

FOR EVERLASTING PROTECTION

pared to 1000 Btu for the composite average.

Prior to World War II our coal quality was so uniform that we did not even bother to take individual car analyses. Bunker samples were taken to provide station efficiency figures only. This is all changed. That confidence is gone. All sources are constantly checked.

The cost per million Btu curve shows the cumulative effect of the cross currents of decreasing quality, rising prices and increased freight rates. It rose from 13-½ prior to World War II to 33 cents per million in 1949.

Preparation plants with coal washing and thermal drying are certainly the means by which, where required, quality can be restored and uniformly maintained. This now seems to be the trend. Coal quality is being restored.

The big user tries to understand the position of the coal industry in their efforts to offset the increased mining costs brought about under the present day conditions. In the current highly competitive fuel market, miners are expected to produce more coal to offset their raises. One hundred per cent of a seam is now mechanically sent to the tipple or preparation plant — where before the war perhaps twenty per-cent of the seam was discarded as mineral layers inside, below or above the good section of the coal. In this manner over-all costs are reduced to keep prices down at a sacrifice of quality unless the coal is also mechanically cleaned to keep quality up. When the coal situation becomes sufficiently competitive, quality must be improved even at some sacrifice in costs.

The laboratory report will then be a routine piece of paper rather than a target of criticism or doubt; the problems now presented to the user by the laboratory sheet will have disappeared; and the cautions now heading toward increased limitations and penalty clauses will become relaxed; all these from the standpoint of the producer as well as the user.

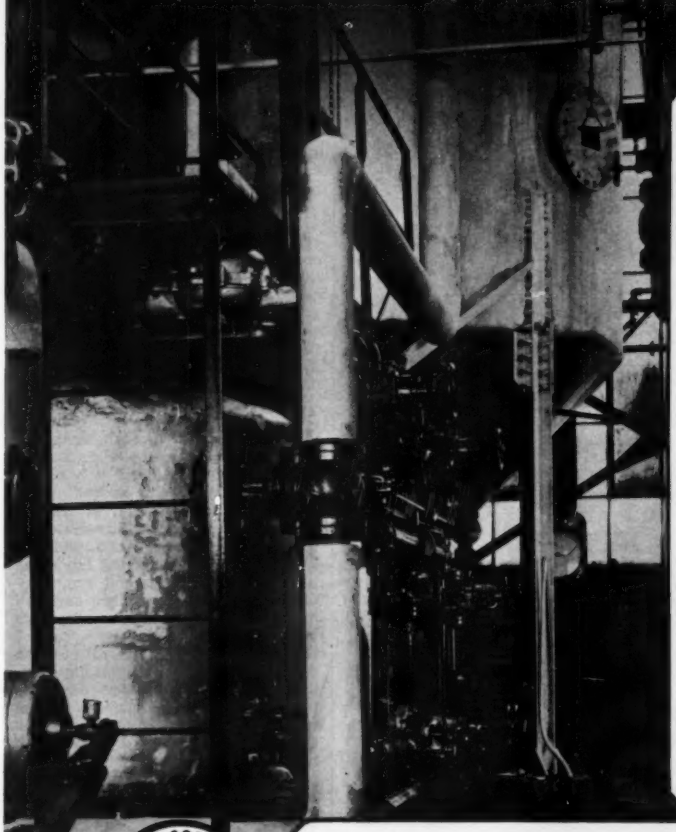
DESIGN FACTORS

(Continued from page 87)

active radiant surface and consequently permits a still larger furnace to be built than would otherwise be required while still utilizing full water cooling of the furnace wall surfaces.

A series of limitations are imposed upon boilers by the character of the fuels to be handled. This is particularly true in the case of the puverized coal furnace wherein ash fusion temperatures must be considered in determining the heat absorption surface and the volume of the furnace. The dry bottom type of furnace usually has very low specific heat release rates and very large amounts of water cooled surface. Conversely the slagging type of

COCHRANE DEAERATING HOT PROCESS SOFTENER FOR CYANAMID'S BOILER FEED



At the Gloucester, N. J. plant of American Cyanamid, a Cochrane Deaerating Hot Process Softener of 64,000 lbs/hr capacity is used to condition feedwater for a 60,000 lb/hr Babcock & Wilcox boiler and for a packaged steam generator of 300 h.p. Chemical feed and two Cochrane 5'6" anthracite filters are also part of this installation. Cochrane have been pioneers and leaders in the field of water conditioning for boiler plants for over half-a-century. Thousands of installations all over the world testify to the soundness of Cochrane design and the reliability of Cochrane construction.

COCHRANE CORPORATION
3123 N. 17th St.
Philadelphia 32, Pa.

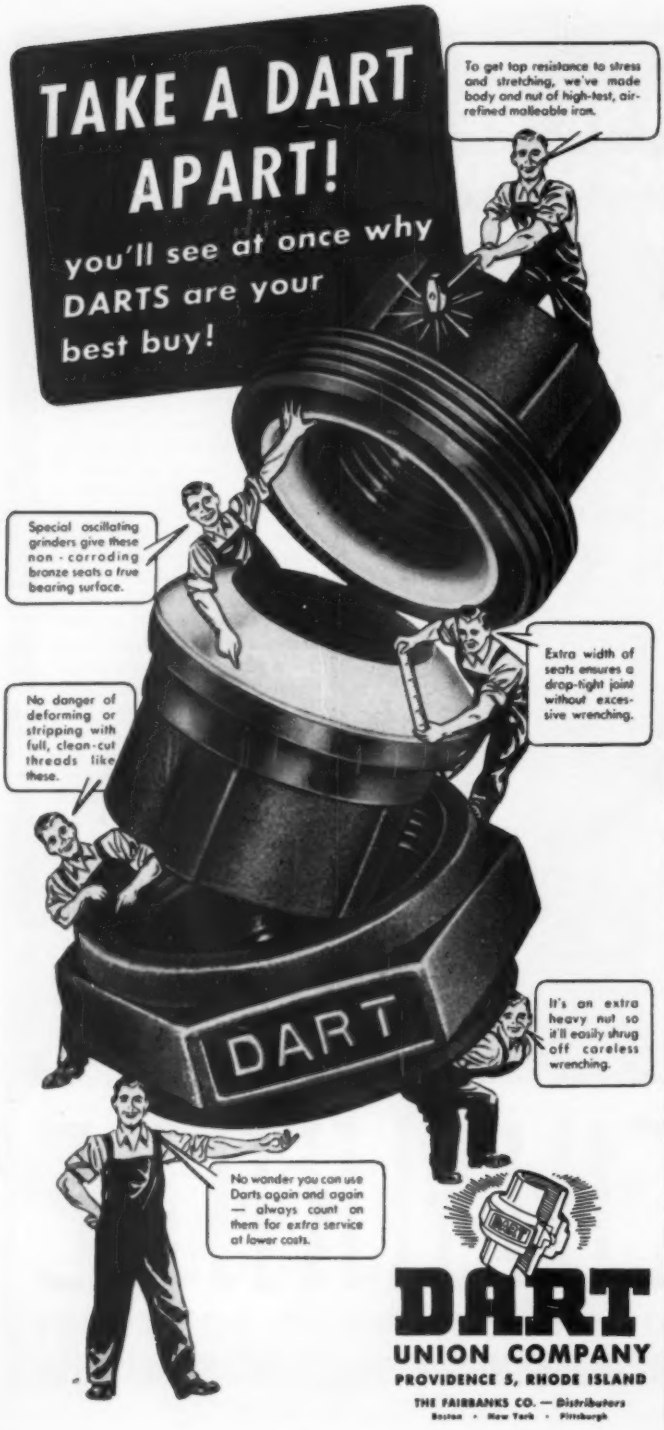
In Canada: Canadian General Electric Co., Limited, Toronto
In Mexico: Babcock & Wilcox de Mexico, S. A., Mexico City
In Europe: Recuperation Thermique & Epuration, Paris

COCHRANE CORPORATION 88 YEARS OF SERVICE 1863-1951

COCHRANE CORPORATION PENNA

COCHRANE

HOT PROCESS WATER SOFTENERS


TAKE A DART APART!
you'll see at once why DARTS are your best buy!
To get top resistance to stress and stretching, we've made body and nut of high-test, air-refined malleable iron.
Special oscillating grinders give these non-corroding bronze seats a true bearing surface.
Extra width of seats ensures a drop-tight joint without excessive wrenching.
No danger of deforming or stripping with full, clean-cut threads like these.
It's an extra heavy nut so it'll easily shrug off careless wrenching.
DART
No wonder you can use Darts again and again — always count on them for extra service at lower costs.
DART
UNION COMPANY
PROVIDENCE 5, RHODE ISLAND
THE FAIRBANKS CO. — Distributors
Boston • New York • Pittsburgh

furnace necessarily limits the furnace heat absorption, in order to maintain fluid ash conditions and the resultant high temperatures involved at the furnace floor. This generally produces a flame and gas temperature so high that some supplementary protection is necessary for the furnace lining.

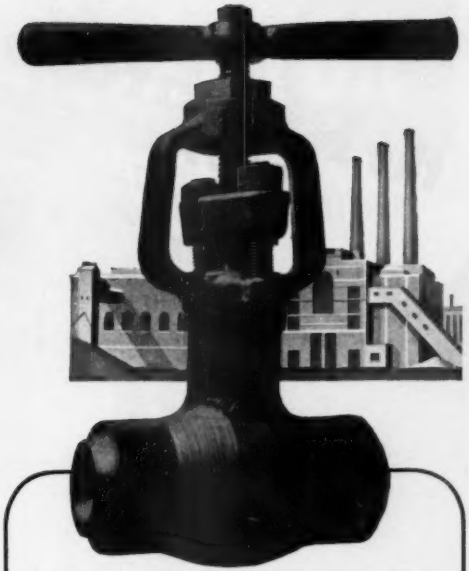
The sulphur content of the fuel establishes a definite economic limit on the amount of heat that can be removed from the waste gases. With low sulphur fuels, it is often economically feasible to bring the exit gas temperatures leaving the air heater down as low as 250 to 275 F. Temperatures this low will cause excessive corrosion in the case of high sulphur fuels and in consequence, exit gas temperatures upwards of 350 F are often specified where the fuel supply conditions contemplate the use of relatively high sulphur fuels.

The entire problem of designing a modern complete steam generating unit is extremely complex. In order to meet a specific steam condition, feedwater temperature, fuel characteristic, and method of firing it is necessary for the boiler designer to take into account limiting temperatures not only in the furnace, but also the economic limits of temperature differential between the gases and the heat transfer surface throughout the boiler. The very high pressure, high temperature units typified by Fig. 3 normally receive feedwater only a few degrees short of the boiling point. The economizer section is limited is size due to the relatively small temperature rise that remains to be obtained in the water. At the same time, the high superheat temperatures require more surface and demand relatively hotter gases passing over the high temperature end of the superheater. As a result of these demands, the modern high capacity, high temperature boiler produces practically all of the steam in the furnace water wall surfaces. Additional heat is extracted by the superheater and a limited amount by the economizer, but for high pressure service, the gas exit temperature from the boiler proper is quite high. This, in turn, demands a large air heater if the dry gas heat loss is to be held to low values. This again implies a necessarily high temperature for the combustion air.

High temperature combustion air cannot be effectively utilized on stoker fired units due to the limitations imposed on the air temperature applied to the grate system. On the other hand, all furnaces firing fuels in suspension are remarkably free from any upper air temperature limit, due to the fact that the combustion air does not meet with the fuel until it actually enters the furnace. In the case of the pulverized coal fired units, heated air which goes to the pulverizers is tempered

When HANCOCK *Valves go in*

Valve costs go down



HANCOCK 1500# and 2500# WELDVALVES are "top of the league" for sure, safe, and dependable service. These modern-design valves are the overwhelming choice of design and operating engineers of high-pressure steam plants.

And here are the major reasons: A functional design that positively eliminates leakage at the three spots where most ordinary valves will leak —bonnet joint, gaskets, and seat inserts, seat and disc life that is permanent, lighter valves that also save space yet will stand up in the most severe installations.

Two valve body sizes cover all pipe sizes up to and including 2 inches. Service rating up to 2500#–1050° F., W.S.P. and 6000#–100° F., O.W.G. Sizes from ¼ inch through 2 inches.

Install Hancock WELDVALVES once for the life of your boiler and lines!

HANCOCK 1500# & 2500# STEEL WELDVALVES

2 "Old Pros" on our winning team . . .

No team would be complete without a couple of "old pros" — dependable in action, solid as a line drive, sturdy as the player behind the plate. Hancock 1500# and 2500# Steel Weldvalves are the old "pros" of the Hancock Valve Line-Up.

In service in the majority of high pressure, high temperature power station installations! Here's why . . .

- Compensating yoke structure.
- Welded bonnet eliminating bonnet flanges and gaskets, means no bonnet leaks.
- Integral stellite seats.
- Major weight reduction to lessen piping strains.
- Can be serviced and maintained without removing from line.
- Size Simplicity. One size and design for ½", ¾", 1"; a second size covers 1¼", 1½", 2".

HANCOCK *Valves*

A PRODUCT OF

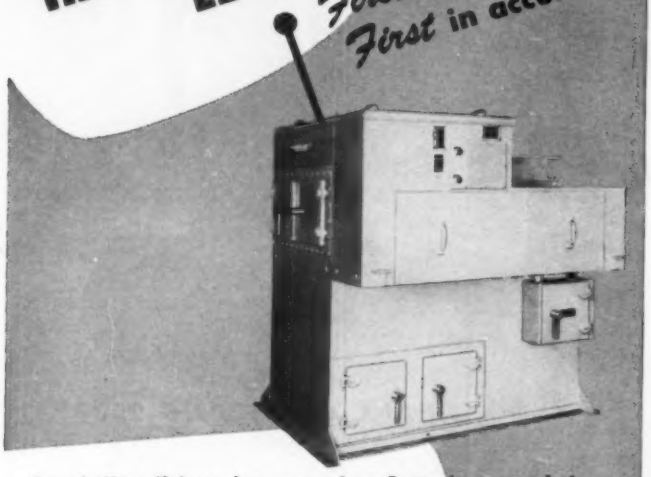
MANNING, MAXWELL & MOORE, INC.

WATERTOWN 72, MASSACHUSETTS

Makers of 'Hancock' Valves, 'Ashcroft' Gauges, 'Consolidated' Safety and Relief Valves, 'American' Industrial and 'Microsen' Electrical Instruments. Builders of 'Shaw-Box' Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties.

the Richardson EE-39 COAL SCALES

First in efficiency
First in accuracy



Low boiler efficiency is a money hog. It can be stopped almost before it starts—with a Richardson EE-39 Coal Scale. Here are some of the reasons the EE-39 should be your first consideration. Compare them with any other scale *BEFORE* you buy.

- **A 20" x 20" inlet opening, biggest of any coal scale assures positive coal flow—no "hanging-up."**
- **Simple-to-operate by-pass mechanism, enabling coal to be re-routed to stoker or pulverizer.**
- **Pivoted leveling plate provides shallow, even coal flow, uniform "breakaway." Eliminates power or belt strain when occasional lumps pass through.**
- **Warp and twist-free weigh beam of heavy, welded members, mounted on hardened steel knife edges.**
- **Pressure-tight access doors located to provide easy inspection of weighing chamber.**

PLUS —a complete line of accessories such as "Monorate" distributor, discharge counter, remote by-pass control, etc.

For complete information write now to Richardson Scale Co., Clifton, N. J. for Bulletin 0150.

Ask a Richardson engineer to survey your present methods of checking fuel consumption and boiler efficiency. His recommendations will be based on almost 50 years of materials handling by weight experience. No obligation, of course.

7488

RICHARDSON SCALE COMPANY
Clifton, New Jersey

Richardson

Atlanta • Boston • Buffalo • Chicago
Cincinnati • Houston • Minneapolis
Montreal • New York • Philadelphia
Omaha • Pittsburgh • San Francisco
Toronto • Wichita

with cooler air to provide a uniform temperature in the coal-air stream to the burners. Normally, these temperatures are in the neighborhood of 150 to 180 deg. Since the primary air flow is usually less than 10 per cent of the total air handled, almost a complete utilization of all heat recovery possible from the air heater can be made.

It is significant to note that the highest performance units invariably are those firing fuels in suspension wherein full utilization can be made of the heat recovery in the air heater.

Modern boiler design has made available fully or partially water cooled furnaces for every size and application of power boiler. Full utilization of these modern designs will produce a boiler plant possessing a maximum of reliability, a minimum of maintenance expense and outage, and will result in a performance efficiency that will be sustained over many years of operation.

NEWS *from* THE FIELD

SYNTHETIC FUEL PLANTS CAN PRODUCE STRATEGIC CHEMICALS IN QUANTITY

SYNTHETIC FUEL processes can play an important part in meeting requirements for strategic chemicals used in the manufacture of such essential products as synthetic rubber, plastics and nylon, James Boyd, director of the U. S. Bureau of Mines, told the 1950 annual meeting of the American Society of Mechanical Engineers.

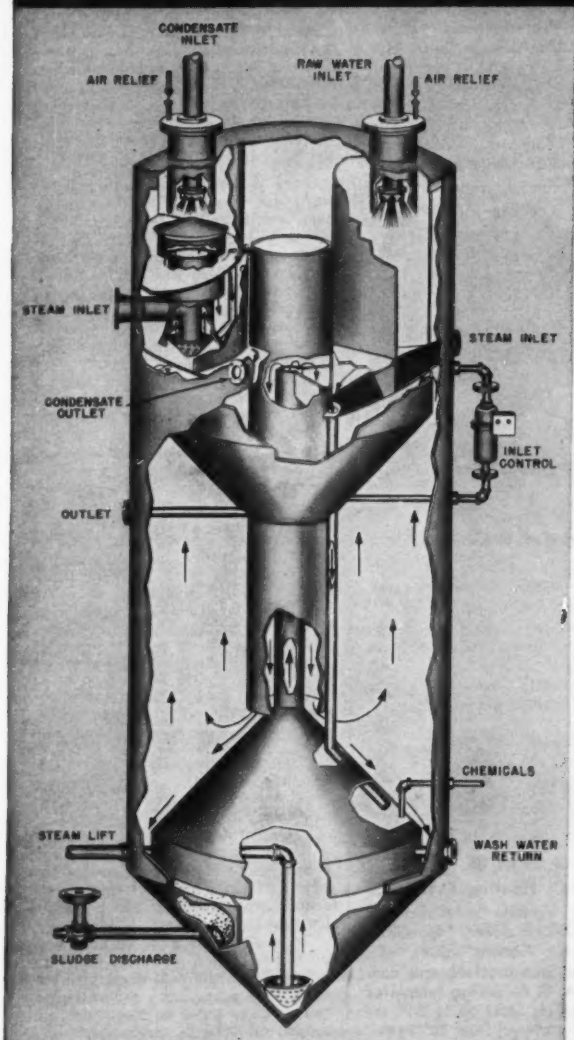
Current shortages and increasing requirements for benzene, phenol, toluene and certain other chemicals could accelerate the schedule for constructing the initial coal-hydrogenation plants, in view of the fact that these chemicals would be produced from such plants in important quantities.

A Bureau of Mines study has determined that a coal-hydrogenation plant could be operated in such a manner that the yields of benzene, toluene and xylenes would be increased by about 25 per cent. This would result in a proportionate reduction in the yield of gasoline.

Many other products are obtainable from coal, but there is no present demand for them because they have never been produced in quantity. Many of these can be recovered by minor process changes.

Shale oil contains significant amounts of aromatic chemicals now in short supply, said Mr. Boyd. The Bureau of Mines has demonstrated in a laboratory unit that benzene and toluene can be obtained from oil

The Hot Process ACCELATOR®



MULTI-PASS TREATMENT FOR

- *Softening*
- *Silica Reduction*
- *Deaeration of Makeup and Condensate*

HERE'S THE ANSWER TO 3 OF THE POWER ENGINEER'S MOST COMMON PROBLEMS

SOFTENING: Positive internal slurry recirculation insures maximum softening, alkalinity reduction, and turbidity removal with a minimum of chemical expenditure. A steam lift effects the recirculation thereby eliminating mechanical pumping devices. A storage compartment within the tank holds sufficient treated water to handle momentary peak demands.

SILICA REDUCTION: Prolonged contact of the water undergoing treatment with the recirculating slurry as well as the redissolving of magnesium in the slurry, reduce silica to a new low.

DEAERATION: The steam lift effectively deaerates the makeup water undergoing treatment, thereby eliminating the need for separate deaerating mechanisms. The condensate enters a separate chamber in the upper portion of the tank and is recycled and scrubbed by its own steam lift system.

Check these advantages of the Deaerating Hot Process Accelator: 1. Self-contained deaeration for both makeup and condensate, 2. Controlled slurry recirculation, 3. Maximum silica reduction by the redissolving of magnesium, 4. Reprecipitation for chemical economy, and 5. An effluent low in turbidity, alkalinity, and hardness. Investigate the new Deaerating Hot Process ACCELATOR. Write for complete information, now.

INFILCO

BETTER WATER CONDITIONING AND WASTE TREATMENT SINCE 1894

INFILCO INC.

NEW YORK 17 • **TUCSON** • CHICAGO 16

SALES OFFICES IN TWENTY SIX PRINCIPAL CITIES

WORLD'S LEADING MANUFACTURERS OF WATER CONDITIONING AND WASTE TREATING EQUIPMENT

shale by a radiant retorting process. If this same process is commercially feasible in large-scale equipment, the yields of these two chemicals would be "very impressive."

Interfuel Competition

While pointing out the necessity of studying the fuel pattern as a whole, rather than any one fuel industry, in order to obtain a true picture for policy making, Mr. Boyd stated:

"The trend in technology is toward expanding the area of interfuel competition, either by introducing new devices for utilization or by increasing knowledge of converting the various fuels into forms usable in present-day equipment. An example of the developing technology of the former type is the gas-turbine locomotive burning powdered coal. The synthetic fuels illustrate the latter."

Petroleum Reserves Limited

In surveying the United States' fuel supply, Mr. Boyd stated the reserves of petroleum are relatively limited. The present decade is one in which authorities in both the petroleum industry and government have indicated that domestic petroleum production probably will pass its peak and may begin to decline.

"Moreover," he continued, "they anticipate that this decade will witness the birth and initial development of a new basic industry engaged in producing synthetic liquid fuels, first from natural gas, then from oil shale and coal.

"Barring unexpected developments in atomic or solar energy, the anticipated gap widening between domestic demand and supply will have to be met by synthetic liquid fuels and imports. It is obvious that the security of our liquid-fuels position will be greatly enhanced when the supply is based in part on solid fuels, such as coal oil shale, which compose more than 95 per cent of our proved fuel reserves."

More Oil and Gas Fuels Used

Since World War II, the trend toward use of oil and gas fuels has been accelerated by the construction of many long-distance pipelines to bring natural gas to major consuming areas and by the utilization of depleted gas and oil fields in the Eastern States as storage reservoirs for gas transported in summer months to augment supplies during peak demand periods in winter.

Liquified petroleum gases, used for heating and other household purposes in rural or remote areas, are today a major petroleum product. Rapid expansion in the use of Diesel engines for rail and highway transport, for construction work, and for farm equipment has increased the demand for the light fuel oils.

There have been record installations of space-heating equipment in the postwar years, and increased quantities of heavy fuel oils have been used in generating electricity. By far the largest amount of petroleum continues to be consumed in our 44,000,000 motor vehicles.

SINCLAIR COAL COMPANY INVESTIGATES NEW UNDERGROUND GASIFICATION METHOD

For the past three years, the Sinclair Coal Co. in cooperation with the Missouri School of Mines has been investigating a new method of underground gasification, which is an addition to coal technology. It involves the use of electric current to form a channel in the coal seam through which air is passed for gasification.

To accomplish this, vertical bore holes are drilled and steel pipes are imbedded in the coal seam at intervals. The pipes have several functions. They serve as electrodes and as gas off-take or air-supply pipes. As demonstrated recently, this is a two-stage method. First, electricity of appropriate voltage is passed between pipe electrodes, and the heat generated carbonizes coal in place with the formation of coal gas, and opens up the channel. Air is then forced down one electrode, through the channel in the coal, and emerges from another electrode as producer gas.

Information about the technique

GOODALL
EXPANSION JOINTS
WITH "FLANG-LOK" FLANGES

Leakproof... Durable ... Easy to Install!

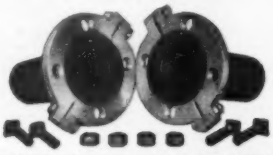
QUICKLY, EASILY INSTALLED. Flared end of joint receives "FLANG-LOK" Floating Flange — a readily bolted split type. It is only necessary to turn flange (not joint or pipe) to align bolt holes with those of connecting flange.

LEAKPROOF, RUBBER-CUSHIONED SEAL. As bolts are tightened, rubber end of joint is compressed over broad area of connecting flange. Magnitude of forces forming seal is in direct ratio to stress applied to bolts.

SUPERIOR STRENGTH, DURABILITY, SAFETY. Special built-up construction, employing rubber, duck and metal, assures widest margin of safety against rated pressures.

PLAIN, EFFICIENT OPERATING PRINCIPLE. All expansion and contraction occurs in center corrugation. Width of corrugation determined by extent of movement required.

FOR ALL STANDARD PIPE SIZES from ⅜" to 96" I.D., on lines carrying fluids or gases under vacuum or pressure, at temperatures up to 250°F. Goodall Expansion Joints, with "Flang-Lok" Flanges, assure real savings in application and service costs. Given installation details, we will gladly quote on your requirements.



"FLANG-LOK" Floating FLANGES
Designed to simplify installation of Goodall Expansion Joints, "Goodite" Flexible Pipe, "Kemite" Duct, etc. Made in cast iron or steel, and conforming to A. S. A. drilling templates in 1" and larger. Sizes up to 24" are made in two sections; from 30" to 96" in four sections. Covered by U. S. Pat. No. 1883086.

Contact Our Nearest Branch or Write for Illustrated Folder

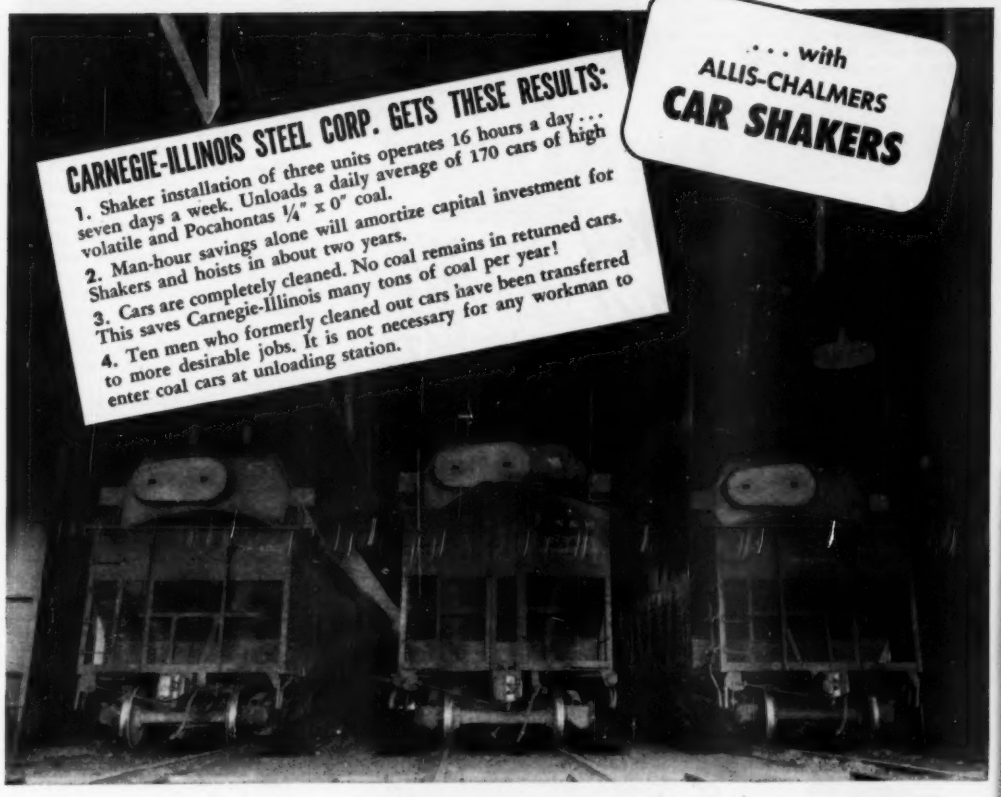
GOODALL RUBBER COMPANY

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

Branches: Philadelphia · New York · Boston · Pittsburgh · Chicago · Detroit · St. Paul · Los Angeles
San Francisco · Seattle · Portland · Salt Lake City · Denver · Houston · Distributors in Other Principal Cities

Est. 1870

STEEL MILL UNLOADS
170 Coal Cars Daily!


CARNEGIE-ILLINOIS STEEL CORP. GETS THESE RESULTS:
1. Shaker installation of three units operates 16 hours a day . . . seven days a week. Unloads a daily average of 170 cars of high volatile and Pocahontas ¼" x 0" coal.
2. Man-hour savings alone will amortize capital investment for Shakers and hoists in about two years.
3. Cars are completely cleaned. No coal remains in returned cars. This saves Carnegie-Illinois many tons of coal per year!
4. Ten men who formerly cleaned out cars have been transferred to more desirable jobs. It is not necessary for any workman to enter coal cars at unloading station.
. . . with
ALLIS-CHALMERS
CAR SHAKERS

YOU CAN GET SIMILAR SAVINGS in demurrage charges and man-hours by installing an Allis-Chalmers Car Shaker. And you save with safety! Accidents are eliminated as workmen do not have to mount the car during the automatic unloading operation.

The Shaker is driven by a 15 hp, high torque, integrally enclosed Allis-Chalmers motor — mounted on rubber to protect motor from severe vibration.

For complete information on how the Car Shaker can help *you* save time and money, contact your nearby A-C Sales Office. Or write for Bulletin 07B7221.

Allis-Chalmers
Milwaukee 1, Wis.

Please send Car Shaker Bulletin 07B7221.

Name .....

Title .....

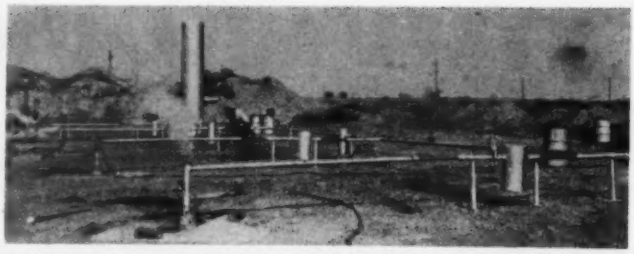
Firm .....

Address A-3171

ALLIS-CHALMERS

and typical test results were presented to a group of coal research men, representatives of technical schools, utility companies, and others, at a demonstration November 13 at Hume, Missouri. The test was made in a two-foot thick seam of high-volatile bituminous coal. T. C. Cheasley is the coal company official who has been active in this project, and Eric Sarapuu is in direct charge of the field tests.

The objective of the work to date has been to establish workable methods and equipment, and to provide basic data on electric breakthrough, carbonization of coal between electrodes, and subsequent gasification by passing air through the channel opened by electric heating.



Test installation of electrocarbonization of coal. Four hollow electrodes at left carry electricity to open channel in coal seam, admit air for subsequent underground gasification, or draw off gas during either stage of process

As explained in the Conveyor of *Bituminous Coal Research* quarterly, during the electrocarbonization stage a gas of 500 to 650 Btu per cu ft is given off. This gas contains about 15 per cent methane and other hydrocarbons, 50 per cent hydrogen, 15 to 18 per cent carbon monoxide, 6 to 8 per cent carbon dioxide, plus hydrogen sulfide, tar vapors, etc., at a carbonizing temperature of 800 to 900 C (1472 to 1652 F). The passage of air was said to yield a producer gas of 120 to 150 Btu per cu ft. The yield and richness of total gas will, of course, depend upon the proportion of coal gas resulting from electrical cabonization and of producer gas made by gasification with air. The results presently available do not represent a complete cycle of carbonizing and gasifying all the available coal between electrodes, and therefore cannot be used as a basis for making conclusive computations.

The sponsors state that the tests have not yet established the practical economics of this interesting new process.

THE OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY

APPLICATIONS ARE now being received by the Oak Ridge School of Reactor Technology for enrollment in the 1951-52 session, beginning September 10, 1951. This School was established at the Oak Ridge National Laboratory in March of 1950 under sponsorship of the U. S. Atomic Energy Commission. Its purpose is to train engineers and scientists in the field of reactor theory and technology, in preparation for their employment in this field by the AEC or its contractors.

The Oak Ridge School of Reactor Technology will enroll students of outstanding qualifications who hold, or will receive by September 1951, bachelor's or master's degrees in chemistry, engineering, metallurgy or physics. A limited number of recent college graduates will be accepted under Category A in the status of student-employees of the

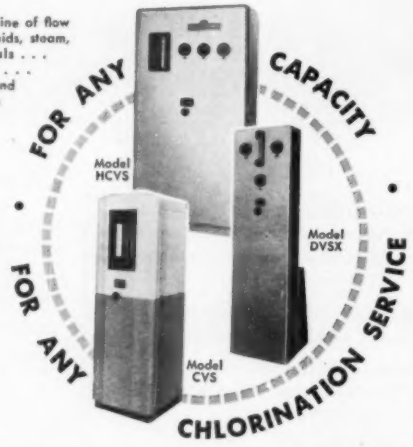
IN CHLORINATION...

...the SIMPLE Way is the BEST Way!

Here's chlorination that's *extra easy*. Plants that use Builders Visible Flow Chlorinizers profit in many ways by their unique simplicity. These chlorine gas feeders *are easy to understand, easy to operate, easy to service*. Chlorination — whether manual, semi-automatic, program, or flow-proportional — is a safe, dependable operation when it's handled by Builders Chlorinizers. They are easily serviced by any competent mechanic and individual parts and sub-assemblies are easily replaceable. For complete information and Bulletins, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 385 Harris Ave., Providence 1, R. I.

BUILDERS makes a complete line of flow meters and controllers for liquids, steam, air, gas, and dry materials . . . mechanical and differential . . . including The Venturi Meter and Chlorizinors (chlorine gas feeders).

Installation at R. I. State Sanitarium, Wallum Lake, R. I.



BIF INDUSTRIES

BUILDERS-PROVIDENCE

BUILDERS

Oak Ridge National Laboratory, and will be paid a monthly stipend for a twelve-month period, beginning September 1951.

Provision is also made for trainees sponsored by government agencies and industrial organizations connected with or interested in the AEC reactor development program, Category B. Applications for enrollment under this category must be made by the firms or agencies employing the applicants. Such students remain on the payrolls of their home organizations.

Much of the material presented in the curriculum of the Oak Ridge School of Reactor Technology will be classified; hence, all enrollments are contingent upon a personnel security investigation.

Men trained in chemistry, engineering, metallurgy or physics are much in demand in the reactor development program. It is the purpose of the Oak Ridge School of Reactor Technology to provide engineers and scientists with sufficient background in reactor technology and allied subjects to become effective as research, development and design personnel.

Further information and application forms may be obtained by writing to the Director, Oak Ridge School of Reactor Technology, Post Office Box P, Oak Ridge, Tennessee. Category for which application is requested must be specified. These applications must be filed with the director of the school by March 1, 1951. Announcements of appointments will be made in April 1951.

INSTRUMENT CONFERENCE AT CARNEGIE TECH

ONE OF THE principal problems confronting industry at the present time is to increase production in a sufficient amount to handle the Government military program, estimated at at least $40,000,000,000.

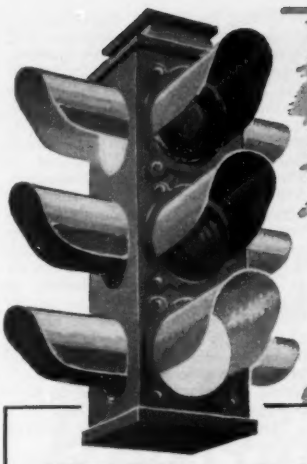
With our plants operating at full capacity and our labor force nearing full employment, the general impression seems to be that there is no slack to take up.

Part of this added production can come from expanding our industries. The steel companies plan to increase capacity ten percent in the next two years.

Nevertheless a goodly portion of the 40 billion added production can come from higher efficiency and higher productivity. Among the factors contributing to increased efficiency and productivity, the use of instruments and automatic controls should not be overlooked.

The Instrument Society of America has for its aims and objectives the advancement of the arts and sciences connected with the theory, design, manufacture and application of instruments in the various industries.

With this in mind, the Pittsburgh

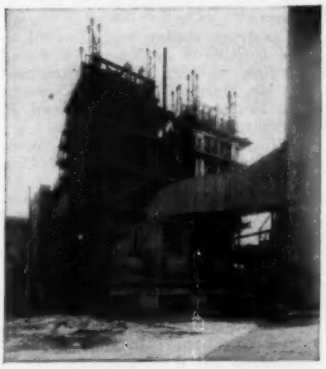


DRAFT FANS GO on GREEN

GREEN FANS . . . Used by Many Leading Utilities

One significant fact about Green Fan Installations at the New Orleans Public Service Plant is that two different boiler manufacturers were involved . . . two different types of boilers but Green Draft Fans for all three boilers. Each boiler has two Green Induced Draft Fans and one Green Forced Draft Fan.

When a concern has specialized on an important piece of power plant equipment for many years, that firm is rightly called the "authority" on the subject. This is the position of Green Fuel Economizer Co. in the field of mechanical draft fans. The name Green is synonymous with Draft Fans highly acceptable to industry.



The Line of Green Induced and Forced Draft Fans includes many types in many sizes which are described in Bulletin No. 168. We shall be glad to discuss your fan requirements with your own engineers, with your consulting engineers and with the boiler manufacturer of your choice.

THE GREEN Fuel Economizer COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

KEEP
SCALE
TO A MINIMUM

CHECK BOILER WATER
FOR pH AND PHOSPHATE

There's the Value!

IT'S FAST AND EASY
WITH A TAYLOR
BOILER WATER
COMPARATOR!

It takes only a minute or two to determine pH or Phosphate, since all color standards necessary for a determination are enclosed in one plastic slide . . . no breakable single standards to handle. Maximum accuracy is assured . . . *for all Taylor Liquid Color Standards carry an UNLIMITED guarantee against fading.* Their low cost, extreme accuracy and simplicity of operation have made Taylor Boiler Water Comparators the accepted tool throughout industry.

Model P contains either High or Low Phosphate Comparator. Model W (shown above) contains same, plus 3 pH slides (pH 7.2 to 8.8); (pH 8.6 to 10.2); (pH 10 to 11.6) plus accessories and instructions for use.

YOUR DEALER WILL DELIVER!

VALUABLE REFERENCE BOOK

. . . yours without cost!

"Modern pH And Chlorine Control" . . . 96 pages, profusely illustrated, covers theory and practice in 34 basic industries. No obligation . . . write today!

W. A. TAYLOR AND CO.
410 ROGERS FORGE RD • BALTIMORE 8, MD

Section of the Society with the Carnegie Institute of Technology will cosponsor a conference on "Instrumentation in the Steel Industry." The Pittsburgh Sections of the following National Societies are cooperating with the Instrument Society: American Institute of Electrical Engineers, American Institute of Mining & Metallurgical Engineers, American Iron & Steel Institute, American Society for Metals, American Society of Mechanical Engineers, American Society for Testing Materials, American Welding Society, and the Engineers Society of Western Pennsylvania. The meetings will be held March 28 and 29 at Carnegie Tech. All industries are urged to send their engineers and production men to these sessions offering information of value to their companies.

The program for this conference includes the following:

Forum on Pneumatic, Hydraulic and Electro-Servo Mechanisms

The forum will be conducted by a three-man panel composed of the following members:

Mr. Elwood T. Davis of the Leeds and Northrup Co. will present a paper on *"Electric Servo Mechanisms,"* Mr. H. Ziebolz of the Askania Regulator Co.—the paper on *"Hydraulic Controls"* and Mr. A. A. Markson of the Hagan Corp., the paper on *"Pneumatic Controls."*

"Comparison of Methods of Measuring Molten Metal Temperatures" by Mr. J. W. Percy, U. S. Steel Corp.

"Instrumentation in Controlling the Welding Variable" by Mr. Julius Heuschkel, Westinghouse Electric Corp.

"Instrumentation and Control in the Utilization of Mixed Fuels and Oxygen in Open Hearth Furnaces" by Mr. Martin J. Conway, Consulting Engineer, and Mr. Edward H. Cauger, Wheeling Steel Corp.

"High-Speed Reheating of Seamless Steel Tubes" by Mr. H. W. Cox, National Tube Co.

"Methods for Sorting Mixed Metals" by Mr. Anthony Doschek of Doschek Associates.

"A Thermal Couple System for Molten Metal Temperature Measurement" by Mr. Lester Veiock—Heppenstall Co.

"The Industrial Application of the X-Ray to the Inspection of Steel Castings" by J. N. Flanagan—Pittsburgh Ordnance District Ordnance Corps.—U. S. Army

14th MIDWEST POWER CONFERENCE

THE FOURTEENTH annual Midwest Power Conference will be held April 4 ,5, and 6, 1951 at the Sherman Hotel in Chicago, Roland A. Budenholzer, professor of Mechanical Engineering at Illinois Institute of Technology, announced recently.

Budenholzer is director of the annual conference on the production,

THEY seal better... last longer...

BELMONT
SHEET PACKINGS

Wherever flange and parallel surface joints must be connected for long trouble-free service—always select Belmont, the Better Sealing . . . longer lasting Sheet Packings. . .

Long experience has made sheet packing manufacture a SPECIALTY with Belmont, that's why Belmont Sheet Packings are selected for every temperature...every pressure...every conceivable type of service.

You can get standard Belmont Sheet Packings—made of compressed asbestos, asbestos metallic, red rubber, cloth inserted, vegetable fibre and a wide range of other constructions. However, whether you require standard or special sheet packing, remember — you always get better sealing . . . longer life with Belmont.

CUT YOUR
OWN GASKETS
WITH BELMONT GASKET CUTTER

A portable tool for cutting 1¼" dia. to 19" dia. circular gaskets from all kinds of soft sheet packings. Rigid and simple to operate. Larger sizes only require cutter bar replacement.

THE BELMONT PACKING
AND RUBBER CO.
Butler and Sepviva Streets
Philadelphia 37, Pa.

There's a Belmont Packing for every service

Rings · Spirals · Coils · Reels
Spools · Sheets · Gaskets

Steam · Water · Oil · Gas · Air
Acids · Alkalies · Ammonia

transmission, and distribution of power. Edwin R. Whitehead, director of Illinois Tech's department of electrical engineering, is secretary.

The annual three-day meeting is sponsored by Illinois Tech and 18 Midwestern universities and professional societies. It attracts more than 3,000 power engineers from all parts of the United States and Canada.

A 10-man industry committee aids Illinois Tech in planning and handling the conference. Each member represents a phase of the power industry. Budenholzer named the following men to the committee for 1951:

J. R. Michel, Commonwealth Edison Co., Chicago, central station power plants.

W. A. Lewis, Dean of the graduate school, Illinois Institute of Technology, Chicago, electrical engineering.

R. H. Bradford, Ebasco Services, Inc., Chicago, industrial and small plants.

R. L. Swinney, Babcock and Wilcox, Chicago, steam generators, fuels, and combustion.

Edwin Vennard, Middle West Service Co., Chicago, private and governmental policies relating to power generation and distribution.

H. H. Chapman, Westinghouse Electric Corp., Chicago, prime movers, steam and gas turbines, diesel engines, etc.

William T. Reace, Commonwealth Edison Co., Chicago, engineering sales.

R. T. Hamlon, National Aluminate Corp., Chicago, water, water technology, and atomic energy.

A. H. Kuhn, Pioneer Service and Engineering Co., Chicago, hydro power.

H. T. Phandhoefer, General Electric Co., Chicago, electric distribution system.

Institutions and organizations which cooperate with Illinois Tech in sponsoring the conference are:

Iowa State and Michigan State colleges, Northwestern and Purdue universities, the Universities of Iowa, Illinois, Michigan, Minnesota, and Wisconsin, Western Society of Engineers, Engineer's Society of Milwaukee, National Association of Power Engineers, the Illinois chapter of American Society of Heating and Ventillating Engineers, the Illinois section of American Society of Civil Engineers, and the Chicago sections of American Institute of Chemical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, and American Society of Mechanical Engineers.

CORNELL ENGINEERING PROJECT PLAN

A DISTINCTIVE engineering project plan which places a premium on student ingenuity and initiative has been placed in operation on a college-wide basis in the College of

Steam
plus
CORAVOL
(The Original* AMINE PROCESS)
®
equals
Protection (FROM CORROSION)

Because CORAVOL Circulates to Control Corrosion

CORAVOL circulating throughout your steam system protects it from corrosive attack. **CORAVOL** saves costly pipe repairs and replacements—maintenance labor—hours and days of shutdown loss. **CORAVOL** cleans out clogging rust deposits, improving heat transfer, restoring original capacity of lines and efficiency of valves and traps.

CORAVOL, the original* amine process, has the flexibility that lets it conform to each individual need. The **CORAVOL** *you* will use is formulated to do the best protective job under your own plant conditions.

CORAVOL IS PART OF A COMPLETE TECHNICAL SERVICE which provides special formulas of chemical treatment for: boiler feed water . . . hot water supply . . . refrigerating brine . . . cooling and condenser water . . . rapid scale removal . . . coagulation . . . algae control . . . fuel oil supply . . . soot removal.

*The use of **CORAVOL** in steam systems is covered by U. S. Patent No. 2053024. The Western Chemical Co., owner of this patent, grants licenses under which volatile AMINES purchased from other sources may be used in steam systems upon payment of royalty to Western Chemical Co.

Chemical Water Treatment
WESTERN CHEMICAL COMPANY
717 Washington Street
Kansas City 6, Missouri

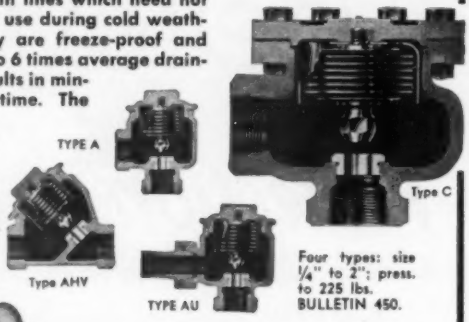
MAIL COUPON TODAY for
Complete Data about the CORAVOL Process
Western Chemical Company,
717 Washington Street,
Kansas City 6, Missouri
Send me full information about CORAVOL.
NAME _____
FIRM _____
ADDRESS _____
CITY _____ ZONE _____
STATE _____

Nicholson Makes

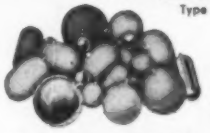
Freeze-Proof Steam Traps

for Every Plant Use

Because they drain completely when cold, these four types of Nicholson steam traps are positively freeze-proof. Can be freely installed outdoors. Universally recommended for use in lines which need not be in continuous use during cold weather, because they are freeze-proof and because their 2 to 6 times average drainage capacity results in minimum heat-up time. The non-air-binding feature of Nicholson traps also notably facilitates steam transfer in severe weather.



Four types: size ¼" to 2"; press. to 225 lbs. BULLETIN 450.



HIGH-PRESSURE FLOATS—Stainless, monel, steel or plated steel. Welded. In all sizes and shapes; for operating mechanisms and as tanks or vessels. 2-day delivery. BULLETIN 650.

W. H. NICHOLSON & CO., 160 Oregon St., Wilkes-Barre, Pa.

The
MAINTENANCE DEPARTMENT
of
CONDENSER SERVICE
& ENGINEERING CO., INC.
100 RIVER ST., HOBOKEN, N. J.
Offers to do
QUICK—PROMPT
RETUBING SERVICE
on BOILERS — CONDENSERS
HEAT EXCHANGERS
ANYTHING WITH TUBES
24 HOURS A DAY — 7 DAYS A WEEK
365 DAYS A YEAR
SATURDAYS - SUNDAYS
HOLIDAYS
WE CARRY TUBES IN STOCK
CALL — TELEPHONE: Day and Night
NEW YORK: REctor 2-9363
HOBOKEN: HOboken 3-4428

St. Paul, Minn.:
Day—Nestor 9673 - Night—Emerson 3219
Chicago, Ill.:
Day—STate 2-1415 - Night—Shieldrake 3-4735
Boston Mass.:
Day—LAfayette 3-1091 - Night—MYstic 6-4532
Tulsa, Okla.:
Day—Tulsa 5-7717 - Night—Tulsa 4-4860
Phila, Pa.: Day—Wilmington (Del.) 7151
Night—Chester (Pa.) 2-4576
Baltimore, Md.: SAratoga 5285
Atlanta, Ga. Dearborn 4477
Washington, D. C.: Republic 4878
Los Angeles, Cal.: TRinity 7861

Consult Us For:
CHIMNEYS . . .
FURNACE WORK . . .
BOILER SETTINGS

AMERICAN CHIMNEY CORP.
143 Fourth Ave., New York 3, N. Y.
BRANCHES:
BOSTON • PHILADELPHIA • CLEVELAND
DETROIT • PITTSBURGH • CHARLOTTE

Engineering at Cornell, Dean S. C. Hollister reported today.

The program requires each student to complete an individual problem of specific research as part of his final year's work in the five-year undergraduate curriculum. Projects are assigned to single students or to teams of two or more. Although instructors are available for consultation, it is left to the students to use their scientific imagination and technical ingenuity in finding a solution, Dean Hollister explained.

A primary purpose of the work, he said, is to provide the young engineer with experience in research procedures in preparation for development problems which commonly arise in professional work after graduation.

At intervals through the year, he appears before the faculty to discuss his progress and defend his procedures, just as a devlopment engineer might be called before his company's research committee. Final results are incorporated in a report.

The project plan is an adaptation of a program which has been under observation in the five-year course in chemical engineering since it began in 1938. With the other engineering divisions now on the broadened curriculum and about to graduate their first five-year classes in June, it has been introduced this year in the courses in engineering physics and electrical, mechanical and metallurgical engineering.

The chemical engineering projects have occasionally produced significant results and several, such as a process for continuous chlorination of benzene and studies of liquid-vapor compositions, have been published in technical journals.

An ambitious list of projects has been charted by the various divisions, Dean Hollister reported. Among those begun in mechanical engineering are the design of a guided missile and a manufacturing analysis of a new-type pump. Projects in electrical engineering include designs for instruments for psychological measurements and of a network analyzer for the school itself.

In typical problems in engineering physics, students are planning improvements for the electron microscope and investigating the elastic behavior of metals under high stress. Students in metallurgical engineering are working on the control of oxygen content in electric steel, the flowability of molding sands and similar problems.

Dean Hollister described the Cornell Engineering Project Plan as a departure in undergraduate engineering education and commented: "The faculty recognizes that the most sought after quality among students is the quality of creative ability and resourcefulness. Our plan gives great promise of being a path to that goal."

WESTINGHOUSE EXPANSION BOOSTS GENERATOR PRODUCTION CAPACITY 65 PER CENT

PLANS ARE under way for two new East Pittsburgh buildings of Westinghouse Electric Corp. that will increase by 65 per cent the capacity to produce giant electric generators.

Mr. T. I. Phillips, vice president in charge of East Pittsburgh divisions, announces that these new structures will provide more than 300,000 extra square feet for large generator production. This will make possible construction of larger than 150,000 kw high-speed, 3600 rpm generators.

Three old buildings, one of them the Meter Works building on Braddock Avenue, are being razed to provide room for the new structures. In place of the old, the new will be: (1) Section D Annex building—large generator production aisle; (2) shipping and warehouse building.

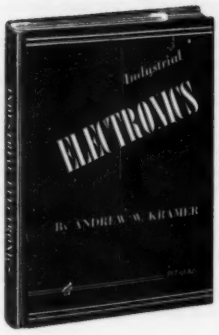
The 1000-ft D Annex, which will be adjacent to the present D-aisle, but with the intervening wall removed, will house two high-level 200-ton cranes (66 feet above the floor) that can team up to carry as much as 350 tons. Below these, 45 feet above the floor, will be three 50-ton cranes that will handle "small stuff."

The new four-story shipping and warehouse building, which will front on Braddock Avenue, will have five electrically-operated tramrail cranes on the first floor and two on the second to expedite materials handling. Reversible rubber-belt conveyors will carry the bulk of smaller materials to all floors. Portions of the third and fourth floors will be used for offices.

The construction contract for the D Annex, to be completed by 1953, but in production by 1952, and the shipping and warehouse building, to be completed by November 1951, has been awarded to the Stone and Webster Engineering Corp. Most of the work will be sub-contracted to Pittsburgh area firms.

TOM MARSH MADE ASME FELLOW

THE GRADE of Fellow in the American Society of Mechanical Engineers has been awarded Thomas A. Marsh, national industrial engineer for Iron Fireman Manufacturing Co., and recognized expert in the combustion engineering field. The honor was bestowed by the Joint Fuels Conference of the Fuels Division, American Society of Mechanical Engineers and the Coal Division, American Institute of Mining and Metallurgical Engineers. This is the second major honor accorded Marsh, who in 1945 received the Percy Nicholls Award, given for notable scientific or industrial achievement in the field of solid fuels.



a practical new book about Electron Tubes

. . . what they are

. . . how they work

. . . how they can be used

. . . what they can mean to you

INDUSTRIAL ELECTRONICS

by Andrew W. Kramer

This new book explains in clear, simple, non-technical style the basic principles of electronics, and how these principles can be applied in industry. Electronics has been solving the unsolved problems. Whether it is navy beans, opening doors at a shadow, or measuring the thickness of red-hot steel plates, the electron is the newest and most efficient force captured by science. This book should be invaluable for the practical maintenance or operating executive or engineer. 311 pages, 229 illustrations, $6.00

CHAPTER HEADINGS: Electron Behavior. Fundamental Principles of Electron Tube. The Simplest Thermionic Tube—the Diode. The Triode. Further Aspects of Triode Characteristics and Operation. Electronic Generation of Electric Oscillations. Multielement Tubes. Effect of Gas in a Tube. Types and Characteristics of Gas-filled Tubes. Mercury-pool Tubes. Photoelectric Tubes and Cells. Cold-cathode Tubes. Special-purpose Tubes. What Tubes Can Do. Electronic Control and Regulation. Application of Electron-tube Rectifiers. Electronics in Instrumentation and Measurement. Industrial Applications of Electronic Control. Application of Electronic Regulation. Electron Tubes in Light Production. Miscellaneous Electronic Applications.

OTHER USEFUL BOOKS FOR ENGINEERS

USEFUL IDEAS FOR POWER ENGINEERS—A "how" book by the editorial staff of Power Plant Engineering furnishing hundreds of ideas on boilers, stokers, fuels, boiler operation, boiler water, refrigeration operation and maintenance, mechanical power transmission.

SECTION HEADINGS — Boilers, Furnaces, Stokers, Oil Burning, Chimney and Stacks, Forced Draft, Boiler Operation, Boiler Water, Boiler Operation Problems, Water for Power Plants, Fuel Purchase, Refrigerating Plant Capacity, Refrigeration Plant Operation, Brine Systems, Air Conditioning, Refrigerating Plant Maintenance, Mechanical Power Transmission. 240 pages, 6x9, 125 illustrations, tables and charts, $2.50

PRACTICAL ENGINEERS OPERATING POINTERS—An excellent compilation by Power Plant Engineering editors of practical pointers pertaining to electrical equipment, turbines and engines, condensers, piping, pumps, etc. It shows you why things are done to save money and secure best results.

CONTENTS—Steam Turbines, Steam Engines, Condensers, Piping, Valves, Flow Measurements, Generators, Motors, Power Factor, Electric Wiring, Distribution Circuits, Fluorescent Lighting, Transformers, Electrical Plant Kinks, Safety Precautions, Distribution Circuit Problems, Piping Kinks, Hot Water and Steam Pumps. 239 pages, 6x9, fully illustrated, cloth binding, $2.50

BOILER FIREMAN'S HANDBOOK—by Joseph R. Darnell, provides boiler firemen and power plant engineers with accurate, dependable data for solving many combustion problems. It also offers many helpful suggestions for the successful operation of various pieces of apparatus found in the power plant.

CONTENTS: Fundamentals of Combustion. Why Flue Gas Temperature Goes Up When the CO_2 Goes Down. Sampling and Analyzing Flue Gas. Interpreting Flue Gas Analyses. Measuring Flue Gas and Furnace Temperatures. Coal Storage and Preparation for Use. Boiler Efficiency Calculated from Flue Gas Analysis and Temperature. Types of Air Pre-heaters and the Effect of Preheated Air on CO_2 Furnace Temperature and Flue Gas Temperature. Natural and Mechanical Draft. Draft Gages and the Measurement of Draft. Hand Firing Methods for Solid Fuels. Stoker Firing Methods. Fuel Oil Firing-Steam Atomization. Oil Firing Methods —Mechanical Atomization. Gas Firing. Pulverized Fuel Firing. Waste Fuels Firing. Heating Feedwater. Flexibility in Firing Equipment and Problems Involved in Converting from One Fuel to Another.

193 pages, 6x9, 139 illustrations, $3.00

POWER PLANT ENGINEERING QUESTIONS AND ANSWERS —8TH EDITION

The information in this book is arranged in question and answer form. This book is not an elementary catechism nor is it confined to the A B C's. It is designed to help you solve those knotty problems which arise from day to day and demand a definite answer on the spot. It covers several hundred problems which are likely to come up in your work and supplies such complete, concise answers that you will find it a mighty useful addition to your engineering book shelf.

Chapter Titles—Power Plant Formulas, Fuels, Water Treatment, Pumps, Steam Engines, Condensers, Refrigeration, Electrical Generators, Electric Motors, Boilers and Furnaces, Combustion, Water Heating, Piping, Steam Turbines, Diesel Engines, Compressed Air, Transformers, Electrical Distributing Circuits.

288 pages, 4½ x 7½, fully illustrated, cloth binding, $2.00

For Sale By

Book Dept., POWER ENGINEERING

110 S. DEARBORN STREET **CHICAGO 3, ILLINOIS**

Marsh has made substantial contributions to the science of fuel burning, and was a pioneer in the successful burning of low rank coals. In addition to design and development work in the combustion field, in which he is a recognized authority, he has contributed liberally to the literature on this and allied subjects. His writings include over 50 articles for technical magazines and some ASME and other Engineering Society papers. He is widely quoted in standard reference and textbooks. He is also the author of two well-known books—"Combustion in the Power Plant" and "How to Buy, Sell and Burn Coal."

Marsh is a registered professional engineer; a life member and now a Fellow in the ASME; member and past-chairman of the executive committee, Fuels Division of the ASME; member of the Universal Craftsmen's Council of Engineers; honorary member of the NAPE; member of the Smoke Ordinance Committee of the ASME and a member of the Cleveland Engineering Society.

* * *

C. S. Beattie has been appointed Executive Vice President and General Manager, and Mr. R. E. Anderson has been named Senior Vice President of Delta-Star Electric Co., a division of H. K. Porter Co., Inc., it was announced by Mr. T. M. Evans, President of both Porter and Delta-Star. Messrs. Beattie and Anderson were also elected directors of the new Delta-Star Electric Co.

Mr. Beattie in his new position will be in charge of all activities of the company. He joined it in 1930 as Sales Engineer in New York and has successfully been Assistant Sales Manager, Manager of Engineering, and Vice President in Charge of Production and Engineering. Before joining Delta-Star, Mr. Beattie held positions with Westinghouse Electric Corp., and United Engineers and Constructors, Inc. He was graduated from Rutgers University with a B.S. in electrical engineering.

In addition to his duties as Senior Vice President, Mr. Anderson will continue to direct the Company's entire sales activities and commercial relations. His experience with Delta-Star dates from 1920. He advanced in the organization through positions as Assistant Sales Manager, Sales Manager, and Vice President. Mr. Anderson formerly held positions with Consumers Power Co., Commonwealth Edison Co., and H. M. Byllesby Co. He holds a Bachelor of Electrical Engineering degree from University of Michigan.

* * *

William L. Hunter, formerly General Manager, has been named Vice-President and General Manager of the Northern Equipment Division, Continental Foundry & Machine Company, Erie, Pennsylvania.

* * *

W. J. Ridout, Jr., Rural Service Manager of the Edison Electric Institute since 1947 has been appointed Editor of Electricity on the Farm Magazine, effective January first, according to an announcement just made by Case-Shepperd-Mann Publishing Corp., New York, publishers of this specialized farm paper. He succeeds the late George W. Kable who had been Editor of Electricity on the Farm Magazine since 1937.

* * *

Warren C. Drummond, Chief Engineer of Pioneer Service & Engineering Co., Chicago, has been elected a Vice President of that company. Mr. Drummond, a mechanical engineering graduate of Montana State College, has been with Pioneer for 25 years, coming from Northern States Power Co. at Minneapolis. He is a member of American Society of Mechanical Engineers and of the Prime Movers Committee of the Edison Electric Institute.

* * *

Plans for the construction of a new $58,000,000 steam generating plant were outlined to the Board of Water and Power Commissioners recently by Samuel B. Morris, general manager and chief engineer of the

NON-PARALLAX
POINTERS
—another feature of
ELLISON STRAIGHT LINE
DRAFT GAGES

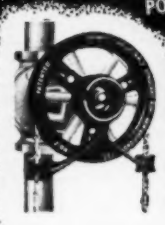
No craning, no straining, no squinting — absolute accuracy with Ellison Bell Type and Diaphragm Type Gages — true readings regardless of elevation from which gages are viewed. Positive, corrosion resistant mechanism. Favorite of power plant engineers since 1896.

ELLISON DRAFT GAGE CO.
214 W. Kinzie St. Since 1896 Chicago 10, Ill.

THE ELLISON LINE ALSO INCLUDES:
Dial Draft Gages—Bell Type and Diaphragm Type. Inclined Draft Gages—Portable Inclined Vertical Tube Gages - Vertical Tube Gages—Oil, Heavy Liquid and Mercury—Single and Multi-Tube - Saturator Gages - U Gages—Stationary and Portable - Air Filter Gages—Dial and Inclined Tube Types - Pilot Tubes - U Path Steam Calorimeters - Portable Gas Analyzers—Orsat Type

ELLISON INSTRUMENTS—Outstanding Design, Construction and Accuracy

POSITIVE! EFFICIENT! SAFER!
VALVE CONTROL AT LOWEST COST!



Babbitt
—Adjustable—
SPROCKET RIM
with Chain Guide

INSTALLED, AND OPERATING, IN ONLY A FEW MINUTES

Range of 10 ADJUSTABLE sizes fits all valve wheels, with rising or non-rising stems, from 2 to 30 inches diameter.

●

Distributors in principal cities, or send for Catalog Folder PE-2 and name of nearest distributor.

● Here's easy, convenient, instant control of overhead, out-of-reach valves — right from the floor! No expensive apparatus, no switches, nothing to break down when needed most! BABBITT Adjustable Sprocket Rim with Chain Guide is installed in a few minutes, and gives you positive, efficient valve control. Low initial cost is last cost! Prevents accidents, prevents waste, saves money!

BABBITT STEAM SPECIALTY CO.
1 Babbitt Square, New Bedford, Massachusetts

Graduate ENGINEERS

GOOD OPPORTUNITIES

for

INSTRUMENTATION ENGINEERS: Five or more years of progressively difficult experience in Instrument Research Development or Design. Must have broad and thorough knowledge of instrument theory and application. Should have some knowledge of Chemical Equipment and its operation. Must be graduate.

POWER ENGINEERS: Must have five to fifteen years experience in some of the following: operating, testing and maintaining power plant equipment, supervising power plant operations, making cost and evaluation studies, heat balance work, power cost accounting, design and layout of power plants, and the selection and installation of power equipment. Must be graduate.

AIR CONDITIONING ENGINEERS: At least 7 years' experience in selection and operation of heating, air-conditioning, ventilating and refrigeration equipment. Well versed in the theory of thermodynamics, fluid flow and heat transfer. For consulting evaluation, and economic operation services. Must be graduate.

ELECTRICAL ENGINEERS: Must have eight to twelve years' broad and thorough experience in electrical design and operating problems of industrial plants with thorough knowledge of selection, installation, economical operation and maintenance of electrical equipment. Must be graduate.

MAINTENANCE ENGINEERS: Five to ten years in planning maintenance work, establishing manpower and material requirements, scheduling and controlling work. Must be thoroughly familiar with Machine and Hand Tools used in Plant Maintenance Work. Must have supervised persons doing maintenance work. Must be graduate. For consultation work.

Give experience, education, age, references, personal history, salary received and salary expected. Please be complete and specific.

All inquiries will be considered promptly and kept confidential.

E. I. du Pont de Nemours & Co.
(Inc.)
Engineering Department Personnel
Wilmington 98, Delaware

Department of Water and Power, City of Los Angeles, Calif.

Proposed site of the new plant, which will be capable of generating 400,000 kw of electric energy, is on land adjoining the Department's present steam plant located in the vicinity of Ocean Avenue and First Street in Seal Beach.

The present Seal Beach steam plant, built in 1925, has two units with a combined generating capacity of 75,000 kw. Plans of the Department of Water and Power call for the building of a new plant with four giant steam turbine generating units, each with a capacity of 100,000 kw. Two of these units are already on order.

Construction of the portion of the new steam plant containing the first two generators will require about three years; the entire project is expected to be completed by 1957.

* * *

THE ALUMINUM CO. of Canada has awarded the Fraser-Brace Engineering Co. of Montreal, a contract for the construction of a new hydro-electric development in the Saguenay region of Quebec. The new project will play a substantial role in increasing the aluminum output of Alcan, now the largest producer in the world. Work will start immediately and will be rushed to completion at the earliest possible date.

* * *

HOBART C. RAMSEY, President of Worthington Pump and Machinery Corp., announced recently the election of the following new officers of its subsidiary, Worthington-Gamon Meter Co., which manufactures liquid meters at its Newark, N. J., plant:

Charles E. Wilson (formerly president), Chairman of the Board of Directors; Robert R. Anderson, President; William C. Flanders, Vice President in Charge of Sales; Walter H. Zeis, Secretary-Treasurer.

* * *

LACLEDE-CHRISTY CO. has announced the appointment of C. A. Gordon as a representative in Buffalo, New York. He will have offices at 930 Prudential Building, Buffalo.

* * *

FOR BETTER SERVICE to industries in the greater Pittsburgh area, Link-Belt Co. has constructed and is now operating a new Factory Branch Store located at 5020 Centre Ave., Pittsburgh 13, Pa. The new store is easily reached by all forms of transportation, being situated just three miles from the Golden Triangle, and only one block from the well-known intersection of Morewood Ave. and Baum Blvd. There is ample parking space on the property. Street car service is available on Centre Avenue and bus line operate on Baum Blvd. The Shadyside Station on the main line of the Pennsylvania Railroad is immediately adjacent to the property.

Discarding condensate because of OIL?

If you are throwing away valuable condensate rather than risk its return to the boiler because of oil contamination, filtration with Sorbo-Cel may be the answer to your problem.

Low in Cost

This specially processed diatomaceous silica powder provides a simple, economical method of removing emulsified oil from water and thereby obtaining an oil-free condensate for boiler feed or other use. Total cost ranges from only 1¢ to 3¢ per 1000 gallons of water filtered.

How it works

A small amount of Sorbo-Cel is simply mixed with the oil-contaminated water, which is then pumped through a pressure filter. Here the oil globules are removed by the specially treated Sorbo-Cel particles, and both are retained upon the filter screen. The filtered water alone passes through.

Does complete job

Sorbo-Cel does a complete job of oil removal. In addition, it removes other suspended matter such as rust, scale, clay and precipitates. And its action is so efficient that large volumes of water can be filtered in a relatively short time.

A bulletin that gives further facts about this low-cost way to remove oil from water is available on request. Just use the coupon below.

Johns-Manville SORBO-CEL

Johns-Manville
Box 290, New York 16, N. Y.
Send me free bulletin giving advantages of Sorbo-Cel filtration.

Name_____

Company_____

Address_____

City_____ State_____

PE-2

HELPFUL BULLETINS

(Continued from page 50)

pictures functioning parts. A diagram shows how chlorinizer operates and there is also a discussion of its operation, safety features, rate of flow indicator, low maintenance costs and installation. Builders-Providence, Inc.

WELDING

131 **Welding Manual**—Bulletin W-17 is a welding reference and instruction book. Illustrated throughout, the contents of this excellent text include technical and pertinent information about every bronze electrode which company manufactures, along with recommended welding techniques and procedures and machining suggestions. Charts covering the selection and preheating of bronze electrodes are also included. Ampco Metal, Inc.

132 **For Welding Cables**—Illustrated Form SL-51, 2 pp, introduces three companion products—solder type lugs and splicers, and block and punch for attaching copper lugs and splicers to welding cables without soldering. Tells what these products are designed to do, how to use them; includes specifications, prices. Tweco Products Co.

METALS

133 **Alloys for Corrosion Protection**—This 4-pp bulletin is devoted to company's aluminum bronze alloys and products made from them . . . welding electrodes, plug valves, centrifugal pumps, safety tools, fittings. Discusses resistance to acids, destructive brines, cavitation erosion, other advantages. Gives physical properties. Ampco Metal, Inc.

134 **Slide Chart**—Technical data on stainless steels is presented in this easily-used slide chart, 4 by 9¼ in. Includes a standard analysis table of stainless steels with their corresponding AISI type numbers and relative fabricating data on the steels for a variety of operations. Machinability is also given, as are specifications for forging, annealing, hardening and drawing of company's stainless steels as well as information on corrosion resistance, Brinell and Rockwell hardness ranges after drawing, tensile strength, elongation, scaling temperatures for continuous service, etc. Forms in which steels are produced are listed. The Carpenter Steel Co.

OTHER EQUIPMENT

135 **Flexible Ball Joints**—Catalog 215, 16 pp, contains complete specifications, dimensions and application data for company's entire line of flexible ball, swing, swivel, revolving and other movable joints for use in piping for power, process, heating, chemical or hydraulic service. Illustrations include many photos of installations. Barco Mfg. Co.

136 **If You Talk About Tubing**—Pocket-size Bulletin TB-335 is a glossary of terms commonly associated with the manufacture and use of steel tubing—a handy little reference book for the man who buys or uses it. Covers the vocabulary of dimensions, grades, manufacturing methods, types, finishes, heat treatments, physical characteristics and mechanical properties. Includes brief bibliography of company's literature on tubing. The Babcock & Wilcox Tube Co.

137 **What's Your Corrosion Problem?**—This small folder on rust preventives for protection of metal surfaces presents both the oil film and petrolatum types, telling how each is used and giving recommended applications. Also tells how to prepare surface before applying rust preventive. Gulf Oil Corp., Gulf Refining Co.

138 **Oil Switch Test Data**—Insert Sheet D4-12 describes recent load break tests on company's Type BA oil switches showing that the full 400-amp carrying capacity of these switches can be interrupted by manual operation. Includes ratings, electrical characteristics of standard models. G & W Electric Specialty Co.

139 **Mechanical Seals for Rotary Shafts**—Illustrated with cutaway drawings in color, this 12-pp booklet covers seals of the positive, chevron, and o-ring types, giving specifications. Shows several typical applications. Also discusses special uses, installation of the seals, and service records. The Garlock Packing Co.

140 **Preheater for Small Plants**—Bulletin S-201-A, 2 pp, describes company's new all steel junior feed water heater for preheating feed water supplies in power plants of 300 hp or less. Illustrated with photos, a cutaway view of the unit and dimensional diagrams; lists specifications, shipping weights. The Swartwout Co.

141 **Diesel Engines**—Company's Series 700 engines for generator drives for electric power supply, pumping on oil or gas lines and other stationary power services are described in Bulletin 320, 4 pp. These are four cycle engines with 17-in. bore, 20-in. stroke and speed range of 257 to 375 rpm. Ratings run from 710 hp for 6-cylinder, normally aspirated, to 2080 hp for 8-cylinder, supercharged engines. Full specifications, dimensions included. The Baldwin Locomotive Works, Baldwin-Lima-Hamilton Corp.

142 **Ejector Instruction Manual**—Bulletin J-50-7 is a 36-pp handbook covering the operation, selection, installation and maintenance of steam jet air ejectors. Discusses such subjects as twin and triple element ejectors, surface and jet inter- and after-condensers, isolating valves, drain traps, steam and back pressures, steam nozzles, condensing water, raw water cooling, recirculation and removal of condensate. Fully illustrated with photos and sketches. Foster Wheeler Corp.

143 **Hydraulic Cylinders**—Technical and engineering data for determining type and size of cylinder best suited to job requirements are presented in Catalog 200, Section 2, 28 pp. Cylinders described are of close grained cast-iron and feature an o-ring sealing arrangement of pliable synthetic material. Discusses seven mounting types available, includes dimensions, parts list, description of accessories; also area quantity and velocity chart and area force and pressure chart. Logansport Machine Co., Inc.

Pritchard

INDUSTRIAL COOLING TOWERS

Help You Save Water!

Pritchard Cooling Towers dissipate heat efficiently . . . economically . . . water savings up to 99% over former wasteful methods. Thoroughly engineered and adequately sized, Pritchard Towers meet peak as well as normal load requirements. Consult your Pritchard representative for the solution to *your* water conservation problem.

Write for *FREE* Bulletins

EQUIPMENT DIVISION

J.F. Pritchard & Co.

Dept. No. 52 908 Grand Ave., Kansas City 6, Mo.

District Offices: Chicago • Houston • New York
Pittsburgh • Tulsa • St. Louis
Representatives in Principal Cities

New *VERSENE test kit determines total water hardness in less than *TWO MINUTES***

Now, with this new Versene* water hardness testing kit you can determine the hardness of your own boiler, process or tap water as easy as ABC—in less than 2 minutes. Anyone who can tell red from blue can make this scientific versenate test and be accurate within one grain of hardness per gallon.

Handy, sturdy, pocket-size plastic kit contains 3 vials of chemicals and one combination measuring and mixing vial. More than 50 separate tests can be made, depending on water hardness. Complete instructions. Refills available. Order The New Versene* Water Hardness Testing Kit today. $5.00 Postpaid. Send Checks or M.O. No C.O.D.'s. Money Back Guarantee. Write Dept. H.

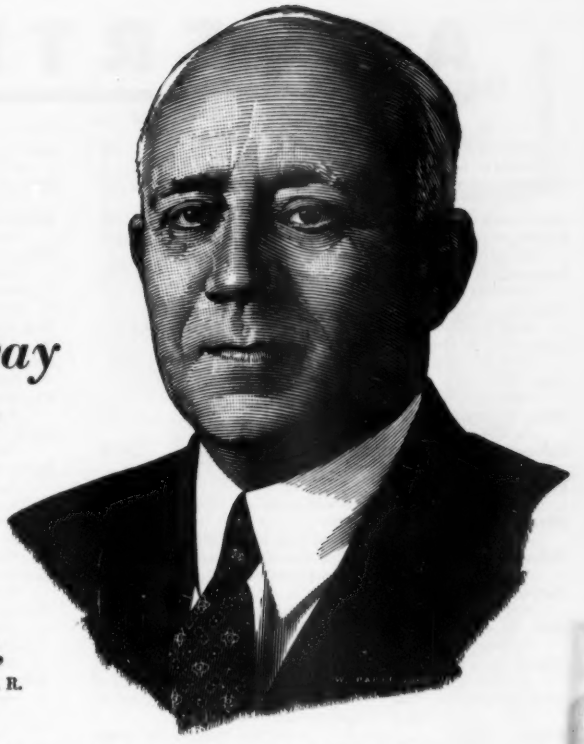
We also manufacture and supply Inhibited Indicator and Di Sodium Versenate (the di sodium salt of ethylene diamine tetra-acetic acid). These are the reagents used in the Versenate (Schwarzenbach) Method for the determination of Water Hardness.

Di Sodium Versenate
50 g. $2.00 100 g. $3.00 500 g. $10.00
Inhibited Indicator
100 cc $1.00 250 cc $2.00 500 cc $3.00 1000 cc $5.00

BERSWORTH CHEMICAL COMPANY
FRAMINGHAM, MASSACHUSETTS

*Trade Mark

"The easiest way to buy Bonds..."



MR. MARTIN W. CLEMENT,
Chairman of the Board, Pennsylvania R. R.

"The easiest way to buy bonds is through the payroll savings plan. We on the Pennsylvania believe in that plan. Labor and management, officers and employees, over half of us are enjoying it. We believe that it is good for our country, that it is good for our company, and that it is good for ourselves and our families to have these savings."

Top executives of more than 20,000 large companies share Mr. Clement's conviction that the Payroll Savings Plan is good for the country, the company, the employees and their families.

Obviously it is good for the country. The monthly purchase of Savings Bonds by more than 8,000,000 Americans is building a huge fund of buying dollars that will be reflected in the sales curves of tomorrow.

And certainly it is good for the company. The employee who puts a part of his earnings in Savings Bonds *every month* is not the type of man whose name appears frequently on the absentee or accident records. Serious savers are serious—productive workers.

For the employee, the Payroll Savings Plan is a positive boon. It is the easy, automatic way for him to build financial independence, provide for the education of children or save money for a home.

If your company does not have a Payroll Savings Plan, here are two things you can do *today:*

Appoint a Bond Officer, one of your major executives—the kind of man who picks up a ball and runs with it. Tell him to get in touch with the State Director, Savings Bond Division, U. S. Treasury Department. The State Director is ready with a package plan—application cards, promotional material, practical suggestions, and all the personal assistance your Bond Officer may need.

Then make a note on your calendar to check the status of your Payroll Savings Plan six months from today—and you will be surprised and gratified at the high percentage of employee participation you will find.

The U. S. Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the G. M. Basford Company and

POWER ENGINEERING

ADVERTISERS

Air Preheater Corp., The 59
Agency—G. M. Basford Company

Allis-Chalmers Mfg. Co. 14-15, 32, 119, 133
Agency—Compton Advertising, Inc.

American Chimney Corp. 138

American District Steam Company, Inc. 107
Agency—Squier and Davis, Inc.

American Engineering Co. 43
Agency—Beatty and Oliver, Inc.

American Pulverizer Co. ..... *
Agency—Batz, Hodgson, Neuwoehner Advertising Agency

Armstrong Machine Works 4
Agency—Russell T. Gray, Inc.

Atlas Valve Co. ..... *
Agency—W. F. Schaphorst

Babbitt Steam Specialty Co. 140
Agency—Paul L. Kuch Advertising

Babcock & Wilcox Co., The 38-39
Agency—O. S. Tyson and Company, Inc.

Bailey Meter Company 46
Agency—Fuller & Smith & Ross, Inc.

Beaumont Birch Company ..... *
Agency—The Harris D. McKinney Organization

Belmont Packing & Rubber Co., The 136
Agency—McNevin-Wilson-Dalldorf, Inc.

Bersworth Chemical Company 142
Agency—Meissner & Culver, Inc.

Betz, W. H. & L. D. 101
Agency—The Harris D. McKinney Organization

Biddle Co., James G. ..... *
Agency—The Roland G. E. Ullman Organization, Inc.

Bird-Archer Co., The ..... *
Agency—Michel-Cather, Inc.

Bowser, Inc. 122
Agency—Willis S. Martin Company

Builders-Providence, Inc. 134
Agency—Hammond-Goff Co.

Cambridge Instrument Co., The ..... *
Agency—E. M. Freystadt Associates, Inc.

Chapman Valve Mfg. Co., The ..... Inside Back Cover
Agency—Sutherland-Abbott

Cities Service Oil Co. 103
Agency—Ellington & Company, Inc.

Cochrane Corporation 127
Agency—Willard G. Myers Advertising Agency

Combustion Engineering-Superheater, Inc. 28-29
Agency—G. M. Basford Company

Condenser Service & Engineering Co., Inc. 138

Crane Co. 57
Agency—The Buchen Company

Dart Mfg. Co., E. M. 128
Agency—Sutherland-Abbott

Davis Engineering Corporation ..... *
Agency—Thomas & Delehanty, Inc.

Davis Regulator Co. ..... *
Agency—Armstrong Advertising Agency

Dearborn Chemical Company 63
Agency—The Buchen Company

De Laval Separator Co., The 37
Agency—Donahue & Coe, Inc.

De Laval Steam Turbine Co. 117
Agency—Geo. H. Gibson Co.

Detroit Stoker Company 111
Agency—Witte & Burden

Diamond Power Specialty Corp. 13
Agency—Witte & Burden

Dowell Incorporated 51
Agency—MacManus, John & Adams, Inc.

Drew & Co., Inc., E. F. 44
Agency—The Aitkin-Kynett Co.

du Pont de Nemours & Co., E. I. 141
Agency—B. K. Davis and Bro.

Eastern Gas & Fuel Associates ..... *
Agency—Ketchum, MacLeod & Grove, Inc.

Edward Valves, Inc. 9
Agency—Gebhardt & Brockson, Inc.

Elliott Co. 2-3
Agency—Peterson & Kempner, Inc.

Ellison Draft Gage Co. 140
Agency—Tri-State Advertising Co., Inc.

Engineer Co., The 18
Agency—Michel-Cather, Inc.

Erie City Iron Works 109
Agency—Davies and McKinney

Everlasting Valve Co. 126
Agency—Michel-Cather, Inc.

Fairmont Coal Bureau ..... *
Agency—The Franklin Industrial Service, Inc.

Fluor Corporation, Ltd. 30
Agency—Dozier, Graham, Eastman

Forty-Eight Insulations, Inc. 106
Agency—Armstrong Advertising Agency

Foster Engineering Company 113
Agency—Sanger-Funnell, Incorporated

Foster Wheeler Corp. ..... *
Agency—Albert Frank-Guenther Law, Inc.

Garlock Packing Co., The ..... *
Agency—Hutchins Advertising Company, Inc.

General Coal Company ..... *
Agency—The Aitkin-Kynett Co.

General Electric Company ..... *
Agency—G. M. Basford Company

Gifford-Wood Co. 12
Agency—O. S. Tyson and Company, Inc.

Goodall Rubber Co., Inc. 132
Agency—George C. Taylor

Graver Water Conditioning Co. ..... *
Agency—Michel-Cather, Inc.

Green Fuel Economizer Co., Inc. 135
Agency—Sanger-Funnell, Incorporated

Grinnell Co., Inc. ..... *
Agency—Horton-Noyes Company

Griscom-Russell Co., The ..... *
Agency—Michel-Cather, Inc.

Hagan Corporation 19-20-21-22
Agency—Ketchum, MacLeod & Grove, Inc.

Hall Laboratories, Inc. 55
Agency—Ketchum, MacLeod & Grove, Inc.

Hays Corporation, The 34-35
Agency—Proebsting, Taylor, Inc.

Huyette Co., Inc., The Paul B. ..... *

Infilco, Inc. 131
Agency—The Vanden Company, Inc.

Johns-Manville 141
Agency—J. Walter Thompson Company

Kellogg Co., The M. W. ..... *
Agency—Gordon Baird Associates, Inc.

Ladish Co. 31
Agency—The Cramer-Krasselt Co.

Link-Belt Company ..... *
Agency—The Advertising Corp.

Manning, Maxwell & Moore, Inc. 129
Agency—Briggs & Varley, Inc.

Marley Company, Inc., The 121
Agency—Merritt Owens Advertising Agency, Inc.

Milton Roy Company ..... *
Agency—Michener & Holland

National Aluminate Corporation 48
Agency—Armstrong Advertising Agency

National Valve & Mfg. Co. ..... *

Niagara Blower Company ..... *
Agency—The Moss-Chase Company

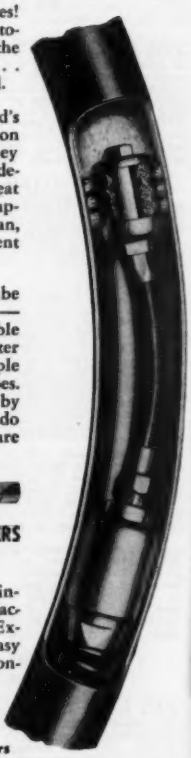
Nicholson & Co., W. H. 138
Agency—Wilbur A. Myers

Northern Equipment Company 65
Agency—Davies and McKinney
Pacific Pumps, Inc. ..... •
Agency—The McCarty Company
Permutit Co., The ..... •
Agency—Cunningham & Walsh, Inc.
Prat-Daniel Corp. 110
Agency—Hening & Company, Inc.
Pritchard & Co., J. F. 142
Agency—Carter Advertising Agency, Inc.
% Proportioneers, Inc. % 42
Agency—Hammond-Goff Co.
Republic Flow Meters Co. 26-27
Agency—Glenn, Jordan, Stoetzel, Inc.
Richardson Scale Co. 130
Agency—O. S. Tyson and Company, Inc.
Riley Stoker Corporation ..... •
Agency—The Davis Press, Inc.
Rockwell Mfg. Co. 9
Agency—Gebhardt & Brockson, Inc.
Rohm & Haas Company 25
Agency—John Falkner Arndt & Company, Inc.
Roto Div. of Elliott Co. 124
Agency—Jos. S. Vogel & Co.
R-P & C Valve Division, American Chain & Cable 114
Agency—Reincke, Meyer & Finn
R-S Products Corporation 36
Agency—Carl M. Craig Agency
Sarco Company, Inc. 54
Agency—Gus Binz Associates
Simplex Valve & Meter Co., The ..... •
Agency—Cunningham & Walsh, Inc.
Sinclair Refining Co. 40-41
Agency—Morey, Humm & Johnstone, Inc.
Southern Coal Company, Inc. ..... •
Agency—Robertson & Buckley, Inc.
Standard Oil Co. (Indiana) 33
Agency—McCann-Erickson, Inc.
Stone & Webster Engineering Corporation 52
Agency—Harold Cabot & Co., Inc.
Sun Oil Company 61
Agency—Gray & Rogers
Swartwout Company, The 6
Agency—Palm & Patterson
Taylor & Co., W. A. 136
Agency—Emery Advertising Corporation
Terry Steam Turbine Co., The 24
Agency—Michel-Cather, Inc.
Texas Co., The ..... Back Cover
Agency—Erwin, Wasey & Company, Inc.
Thermix Corp., The 110
Agency—Hening & Company, Inc.
Treasury Department 143
United States Rubber Company 53
Agency—Fletcher D. Richards, Inc.
United States Steel Corp. ..... •
Agency—Batten, Barton, Durstine & Osborne, Inc.
Universal Atlas Cement Co. (Lumnite Division) ..... •
Agency—Batten, Barton, Durstine & Osborne, Inc.
Vogt Machine Co., Henry 45
Agency—Farson & Huff
Vulcan Soot Blower Division, Continental Foundry & Machine Company ..... •
Agency—Davies & McKinney
Wallace & Tiernan Products, Inc. ..... •
Agency—Branstater-Hammond
Warren Steam Pump Co., Inc. ..... •
Agency—The Davis Press, Inc.
Western Chemical Company 137
Agency—Carter Advertising Agency, Inc.
Western Precipitation Corp. ..... •
Agency—Dozier-Graham-Eastman
Westinghouse Electric Corporation 16-17, 47
Agency—Fuller & Smith & Ross, Inc.
Wheeler Mfg. Co., C. H. 123
Agency—The Roland G. E. Ullman Organization, Inc.
Wickes Boiler Co., The 23
Agency—Price, Hedrick & Tanner, Inc.
Wilson, Inc., Thomas C. 145
Agency—Michel-Cather, Inc.
Wing Mfg. Co., L. J. 105
Agency—Willard G. Myers Advertising Agency
Worthington Pump & Machinery Corp. 125
Agency—James Thomas Chirurg Company
Yarnall-Waring Company 10-11, 66
Agency—Michener & Holland

Firms whose advertising is not in this issue but is appearing in other issues are marked with an •

When Oglethorpe Ogled the Tubes!

He just couldn't believe his eyes! After using a powerful, easy-to-handle Wilson Tube Cleaner, the boiler tubes had "come clean" . . . and Oglethorpe wasn't even tired.



There's good reason for our friend's admiring glances. When Wilson Tube Cleaners go to work, they quickly remove scale and other deposits from tubes of boilers, heat exchangers, condensers, stills, evaporators . . . leave them spic-and-span, ready for another period of efficient service.

There is a fast-acting Wilson Tube Cleaner for every kind of scale — hard or soft, thick or thin, variable in depth. A large variety of cutter heads and accessories make it simple to clean straight or curved tubes. Wilson Tube Cleaners — driven by air, steam, water or electricity — do a "custom" job, save down-time, are more economical.

WILSON-DUDGEON TUBE EXPANDERS

make rolling quick and easy

Use them to re-roll old tubes or install new ones. Precision-manufactured Wilson-Dudgeon Tube Expanders insure solid seating, easy rolling. All sizes, in flaring and non-flaring types, available

WRITE FOR BULLETIN 47A
on Tube Cleaners
and Bulletin 380 on Tube Expanders

THOMAS C. WILSON, INC. 21-11 44TH AVENUE, LONG ISLAND CITY 1, N.Y.
Cable: "TUBECLEAN," New York.

TW-780

WILSON

WILSON TUBE CLEANERS
WILSON-DUDGEON TUBE EXPANDERS

CATALOG LIBRARY

(Continued from page 62)

266 **Coal Scale Manual** — Recently-published Bulletin 0150 describes automatic coal scale construction and operation, illustrating special design features which provide for high accuracy and long service. Richardson Scale Co.

FUEL OILS, LUBRICANTS

267 **Diesels, Their Fuels and Lubricants** —This 46-pp book offers a well organized and attractive presentation of practical information on diesel engines, covering their history and economics as well as their design characteristics and operating principles. Classification of diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and diesel oil purification and filtration. Includes a discussion of fuel and lubricating oil required. Sinclair Refining Co.

268 **Fuel Oil Treatment** — By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. E. F. Drew & Co., Inc.

269 **The Answers on Turbine Oil**—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Standard Oil Co. (Indiana).

270 **Grease Application Devices**—The development and use of many types of lubricating devices are discussed in an excellent article in Vol. 36, No. 9 of Lubrication, company's technical publication on lubricants. Covers the pressure gun, spring type grease cups and several types of power driven grease lubricators, explaining such points as the judicious use of pressure measured lubrication, pumpability characteristics of lubricants. The Texas Co.

METALS

271 **Engineering Data on Inconel** — In addition to providing extensive information on Inconel, 24-pp Bulletin T-7 also presents details on the composition, mechanical properties and physical constants of Inconel X. The International Nickel Co., Inc.

272 **Steels for Hot Spots** — This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels. United States Steel.

CONDENSERS

273 **Condensers** — Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Photos and drawings show assemblies, parts, principles of operation. Condenser Service & Engineering Co.

274 **Steam Condensers with Reserve Flow** — Eight-pp Catalog 410-1 describes a "self-cleaning" reverse-flow condenser for power plant service, designed to virtually eliminate cleaning down time and, in the case of divided water box condensers, eliminate operation at partial load. C. H. Wheeler Mfg. Co.

MECHANICAL POWER TRANSMISSION

275 **Transmission Belting** — Catalog M-9822, 28 pp, gives detailed design, engineering and performance data on transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included. United States Rubber Co.

276 **Hydraulic Couplings** — Bulletin 3924 is Vol. II of "Progress in Power," a 24-pp collection of advertisements covering use of hydraulic couplings in power plants. American Blower Corp.

277 **Worm Gear Drive Manual** — Engineering and ordering data on company's worm gear drives is presented in 88-pp Book 2324. Illustrated with photos and sketches it discusses types of drives and construction features and provides selection tips. Provides ratings, dimensions, overhung and thrust loads. Link-Belt Co.

HEATERS, HEATING

278 **Water Heaters**—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. Davis Engineering Corp.

279 **Fan Heater Bulletin** — Here's a 2-pp illustrated bulletin (No. 109) on a new high pressure steam fan heater designed for complete utilization of both sensible and latent heat of high pressure steam. Niagara Blower Co.

280 **Heat Exchangers** — Bulletin 11.0.080 describes air cooled heat exchangers for condensing or cooling of steam or process vapors, natural gas, jacket water, lubricating oil, quenching baths. Equipment Div., J. P. Pritchard & Co.

281 **Tubular Heat Exchangers** — Bulletin 916, 32 pp, describes tubular heaters, coolers, condensers and heat exchangers and their features. The various types of shells, tube bundles, stationary heads and floating heads are explained. Includes tables showing characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys, and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presents charts of specific heats of midcontinent crudes. Griscom-Russell Co.

DUST COLLECTING

282 **Fly Ash Elimination** — Power engineers will find this 30-pp booklet outstanding among material on this subject. It presents manufacturer's "Multiclone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating duct from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Western Precipitation Corp.

283 **Dust Collecting Efficiency**—How the higher and narrower inlet utilized in company's tubular dust collector contributes to more efficient dust collecting is explained in this illustrated bulletin. Prat-Daniel Corp.

PACKINGS

284 **Pump Packings** — Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes recommendations. Johns-Manville.

285 **Teflon Packings**—Form AD143 offers 8 pp of product information on packings and gasketing material made of Teflon, giving their properties, typical and special applications. Available styles and types are pictured, their construction described and sizes given. Includes chapter on the toxicology of Teflon at extremely high temperatures. The Garlock Packing Co.

286 **Manual on Packings**—Containing 84 pp of helpful engineering and ordering information, Catalog 40 covers packings for practically every service. Illustrates each type, gives sizes, construction and application details. Includes packaging recommendation charts, conversion tables. The Belmont Packing & Rubber Co.

OTHER EQUIPMENT

287 **Turbine Catalog Collection**—This is a valuable collection of bulletins covering a complete description of solid wheel turbines. They feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also includes data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

288 **Velocity Stage Turbines** — Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives specifications, dimensions. De Laval Steam Turbine Co.

289 **Fundamentals of Hydraulics**—Technical Bulletin B-4 is a newly revised 44-pp guidebook covering essential information on hydraulic systems, maintenance, trouble-shooting and selection of proper fluids. Besides offering well-organized reference data to engineering personnel, this book is suggested as a training manual for maintenance supervisors, operators and apprentices. It features specially prepared phantom and cutaway drawings illustrating functions of basic types of valves, pumps, hydraulic motors, torque converters. Shows function of each component part Sun Oil Co.

290 **Ash Handling Systems**—This 24-pp illustrated booklet offers technical information on hydraulic and pneumatic ash and flyash handling systems. Compiled in question and answer form, it discusses elements and advantages of various systems and disposal schemes. Schematic drawings of arrangements under specific conditions and diagrams of basic arrangements are included. Beaumont Birch Co.

CLASSIFIED ADVERTISING

HELP WANTED

WANTED

Experienced Power Plant Superintendent with paper mill experience for large mill in South. Initiative and capable handler of men are primary qualifications. Age preference 38 to 50. Contact by writing Box 1652, Power Engineering, Technical Publishing Co., 110 S. Dearborn St., Chicago 3, Ill.

SALESMEN AND AGENCIES

FOR MEN LOOKING FOR A SALES FUTURE

Opportunities open for sales representatives with a large national manufacturer of power plant feedwater treatment and allied chemical lines for industrial plants. Established territories open. Mechanical or Chemical Engineering degree from accredited college or university required. Under 35 years of age, three years' experience in sales, engineering, production or related fields. Write fully, giving business history and salary requirements. All replies confidential.

BOX 1649

Power Engineering

110 S. Dearborn St., Chicago 3, Ill.

SALESMEN WANTED

With contacts among schools, municipalities, institutions, etc., to handle lucrative line of Wiping and Polishing Cloths, Drop Cloths, Chamois, Pure Bristol Paint Brushes, natural and synthetic Sponges. Full time or as a sideline. State full particulars and territory covered. Central Mills Company, 3920-60 South Loomis Street, Chicago 9, Illinois.

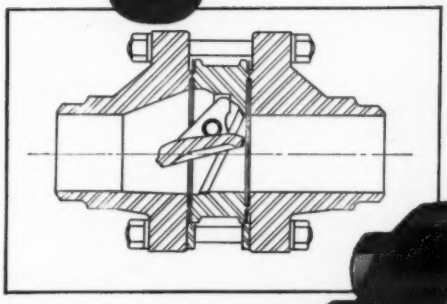
EQUIPMENT FOR SALE

FOR SALE

Three Type C Erie City Cross Drum Boilers, each having 3300 sq. ft. of heating surface and an output rating of 11,385 lbs. of steam per hour from and at 212° F. return water, 160 lbs. operating pressure. Each boiler equipped with four soot blowers, water column, fly ash hopper, 3" steam reinjection system, Copes Feed Water Regulator, two blowoff valves, two pop safety valves and one stop and check angle header valve. Boilers built in 1942, used approximately one year, then prepared for standby. Copies of inspection reports available on request. Boilers at present installed in an idle plant in Central Illinois. Extra equipment available with any or all of the boilers: Three Chicago Automatic Spreader Stokers (some parts missing), two reciprocating duplex steam driven boiler feed water pumps, one Stickle No. 5 Feed Water Heater and Purifier and one condensate tank with two Fisher Flow Control Valves. Will sell part or all equipment in Boiler Room, including valves and pipe work too numerous to list. Associated Sales & Supply Co., 5137 Southwest Ave., St. Louis 10, Mo.

FOR HIGHER PRESSURES

3 Piece Tilting-Disc Check Valve



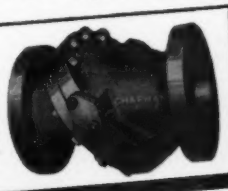
Has Removable Center Section for Quick and Easy Replacement of Operating Parts

Here's a Tilting-Disc Check Valve designed specifically for higher pressures. Its construction permits replacement of operating parts, if ever necessary, without removal of entire valve from the line. Once the studs between inlet and outlet sections of the body are taken out, the entire center section (containing disc, seating face and hinge pins) can be removed. Replacement of center section is fast, easy — an important advantage.

Important, too, is the smooth, easy operation obtained by the tilting-disc design. The balanced disc is held on the open stops by the velocity of the medium being handled. There's no slamming on closure to cause destructive pipe line stresses.

Write for complete description.

STANDARD 2-PIECE TILTING-DISC CHECK VALVES are available in either iron or steel for all pressures.



The Chapman Valve Mfg. Co.
INDIAN ORCHARD, MASSACHUSETTS

GIVE THESE BEARINGS EXTRA PROTECTION

Keep turbine systems free of rust, sludge and foam, by using TEXACO REGAL OILS (R&O)

You won't have to worry about "oil starved" bearings when your turbines are lubricated with *Texaco Regal Oils (R&O)*. These oils are famous for their ability to keep turbine systems free from rust, sludge and foam . . . assuring full circulation of lubricant to maintain normal bearing temperatures and to keep governor response instantaneous.

Only the finest base stocks are used in *Texaco Regal Oils (R&O)*. In fact, *Texaco Regal Oils* were world-famous turbine lubricants for many years before rust- and oxidation-inhibiting additives came into use. Now, with these additives—plus special processing to prevent foaming—*Texaco Regal Oils (R&O)* are truly outstanding. Count on them for extra-long service life . . . extra protection for your turbines.

Texaco Regal Oils (R&O) meet the stringent requirements of all leading turbine builders and are the choice of turbine operators everywhere. Let a Texaco Lubrication Engineer give you full details.

Just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, New York.

TEXACO

TEXACO Regal Oils (R&O)

FOR ALL TURBINES

TUNE IN . . . TEXACO presents MILTON BERLE on television every Tuesday night. METROPOLITAN OPERA radio broadcasts every Saturday afternoon